Climate Change Adaptation

Coastal Land Conservation & Climate Change Workshop

December 2, 2009

Andrew Pitz
Natural Lands Trust

1.
Background

IPCC consensus,
impacts and nature adapting

IPCC: Consensus on Climate Change

IPCC, 2007

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- Warming of the climate is "unequivocal"

IPCC, 2007

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- Warming of the climate is "unequivocal"
- Observed increase in global temperature is likely due to human activities (greenhouse gas emissions)

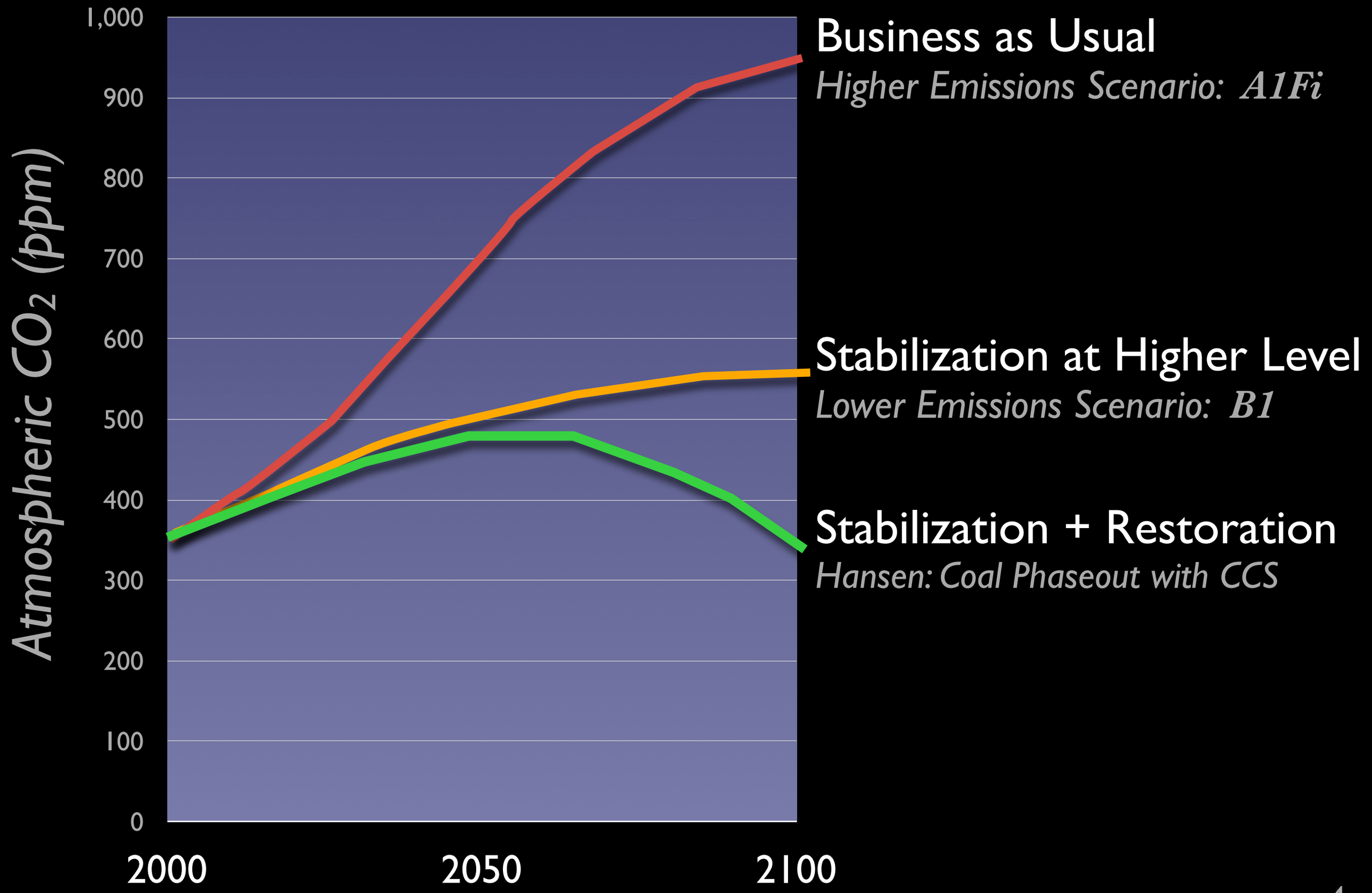
IPCC, 2007

IPCC: Consensus on Climate Change

- Warming of the climate is "unequivocal"
- Observed increase in global temperature is likely due to human activities (greenhouse gas emissions)
- Temperatures will continue to increase even if changes to emissions are made

IPCC, 2007

3 Scenarios for Future Emissions



impacts

Global Climate Change Impacts

IN THE UNITED STATES

June, 2009

U.S. GLOBAL CHANGE RESEARCH PROGRAM

www.globalchange.gov/usimpacts

CHAPTER TWO

July, 2008

Comprehensive Assessment of Climate Change Impacts in Maryland

REPORT OF THE SCIENTIFIC AND TECHNICAL WORKING GROUP
MARYLAND COMMISSION ON CLIMATE CHANGE

Increased Temperatures

2000-07 Average Compared to 20th Century Averages

Observed

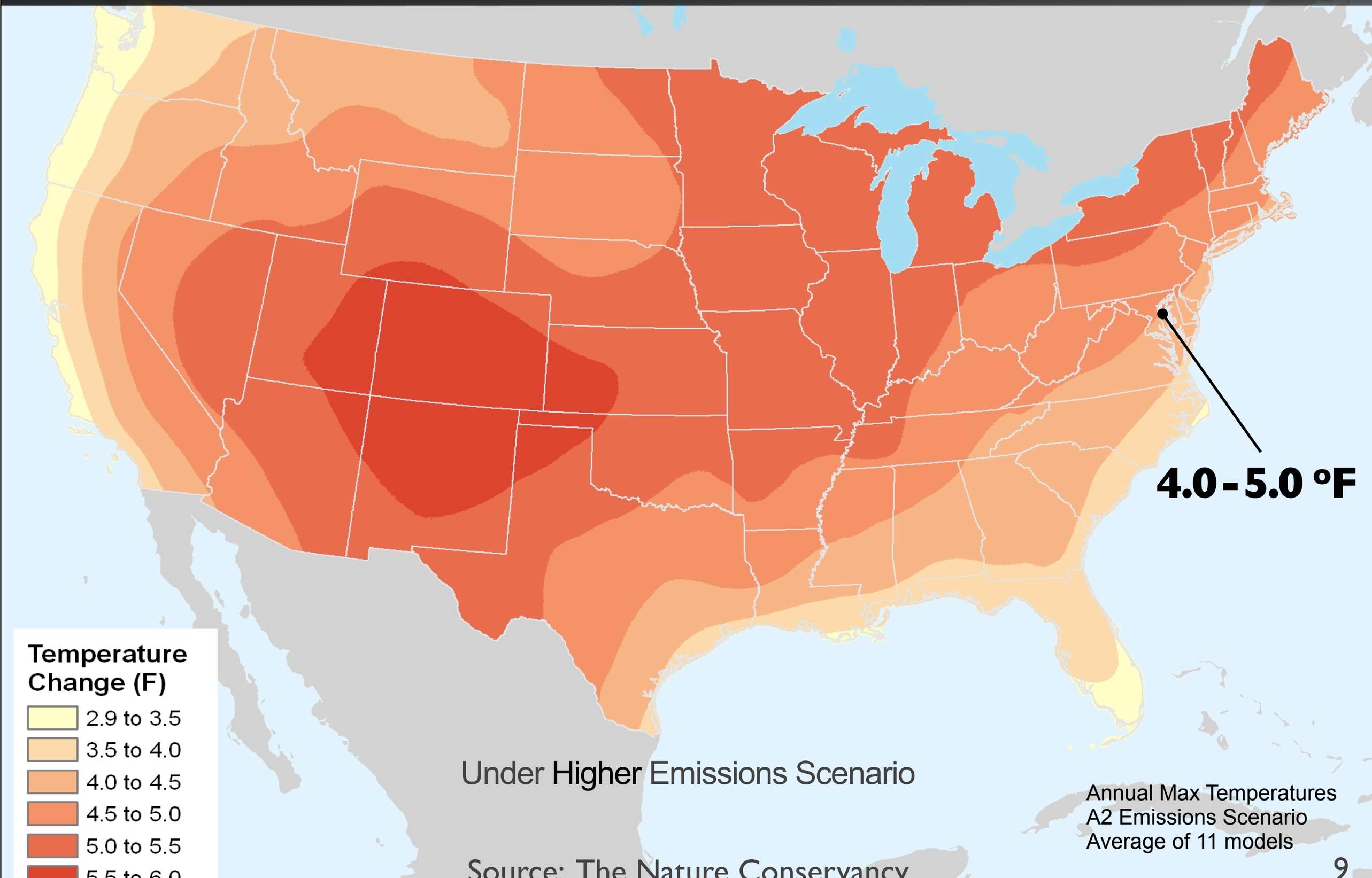
°F

-1.75 -1.5 -1.25 -.75 -.25 .25 .75 1.25 1.5 1.75

Hoerling, NOAA; Saunders et al, 2008, Rocky Mountain Climate Center, NRDC

Increased Temperatures

Projected in 2055



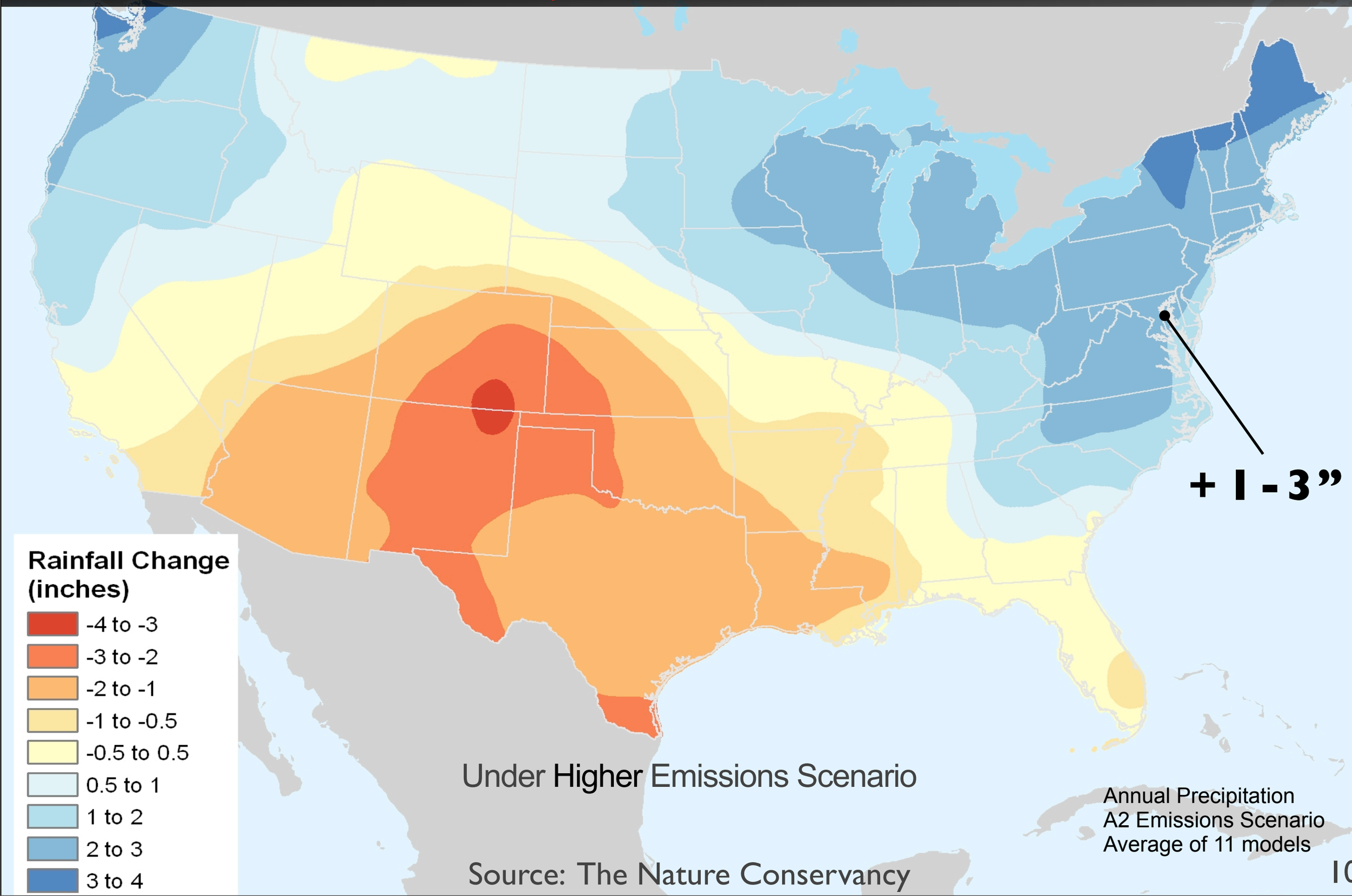
Under **Higher** Emissions Scenario

Annual Max Temperatures
A2 Emissions Scenario
Average of 11 models

Source: The Nature Conservancy

Altered Precipitation Patterns

Projected in 2055



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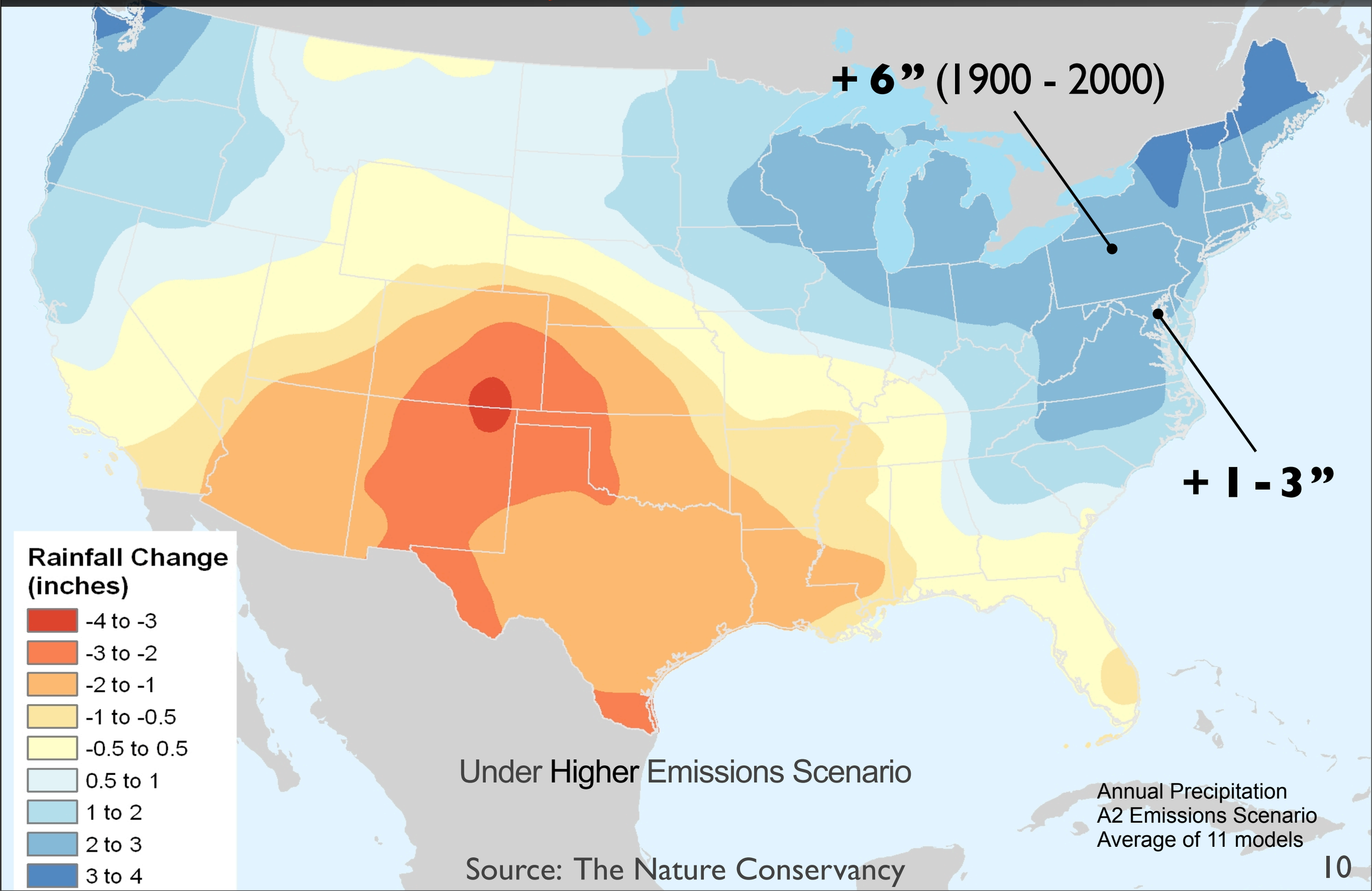


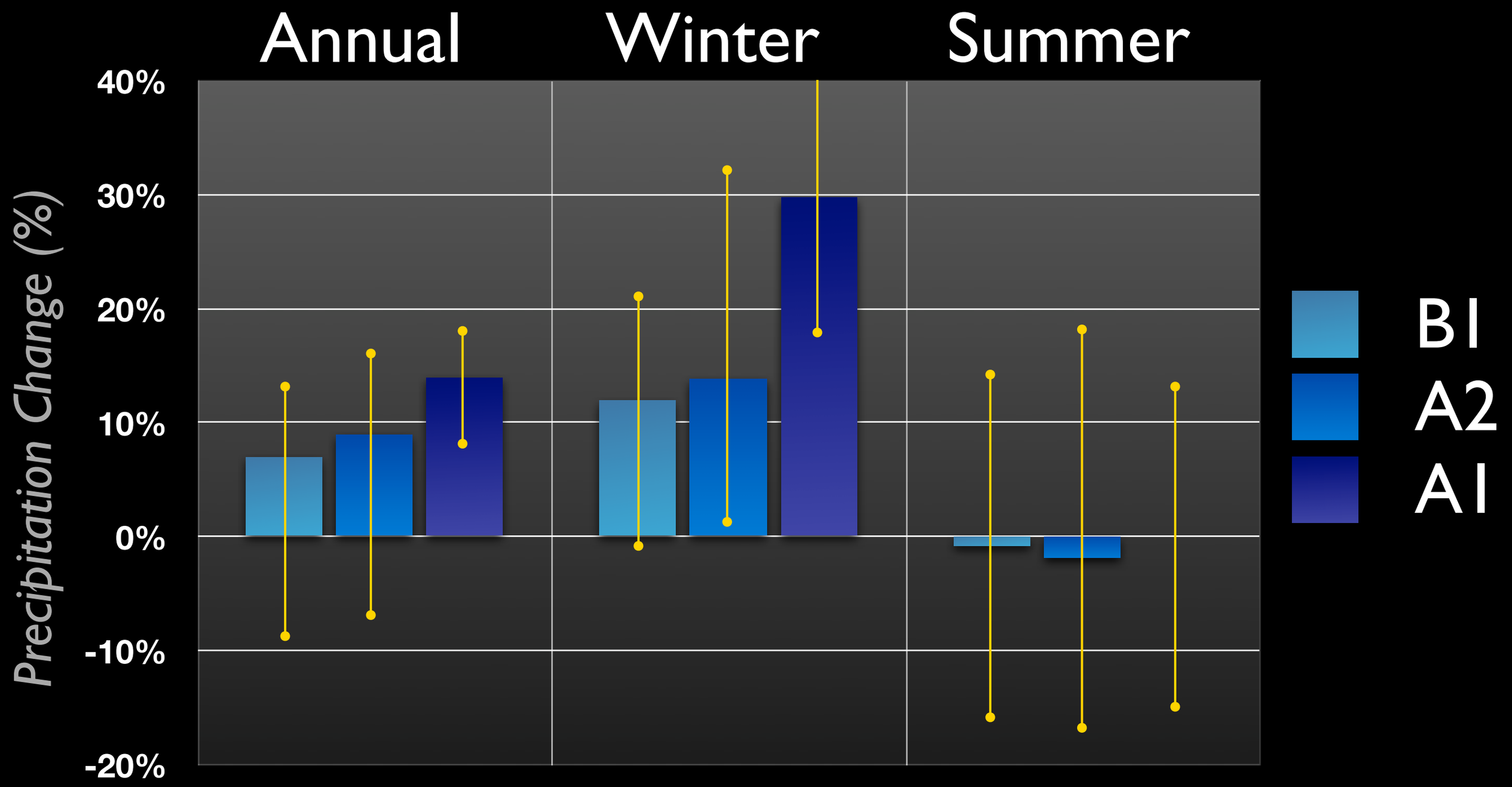
Under Higher Emissions Scenario

Annual Precipitation
A2 Emissions Scenario
Average of 11 models

Source: The Nature Conservancy

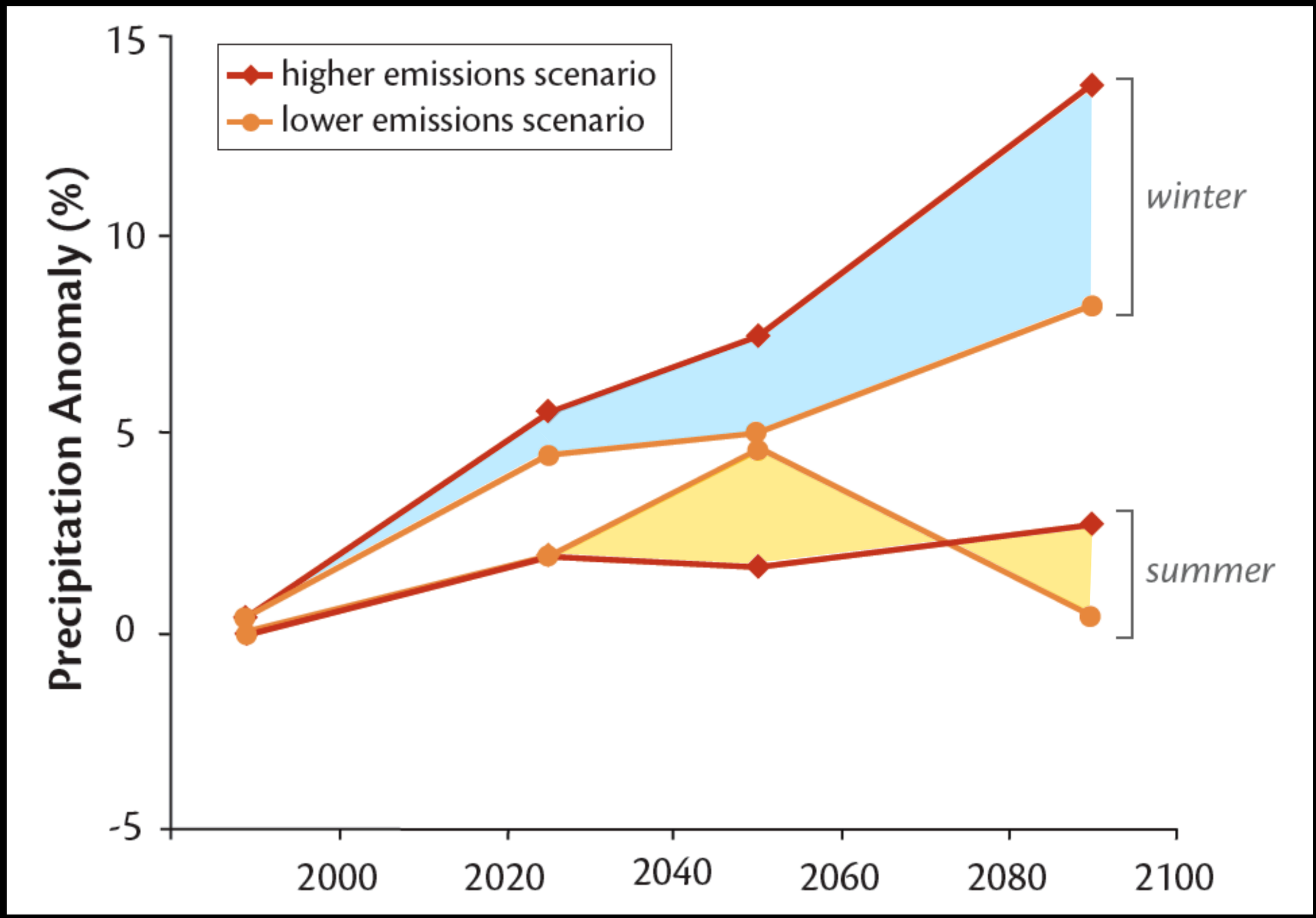
Rising Precipitation in Northeastern US

Projected for 2070-2099



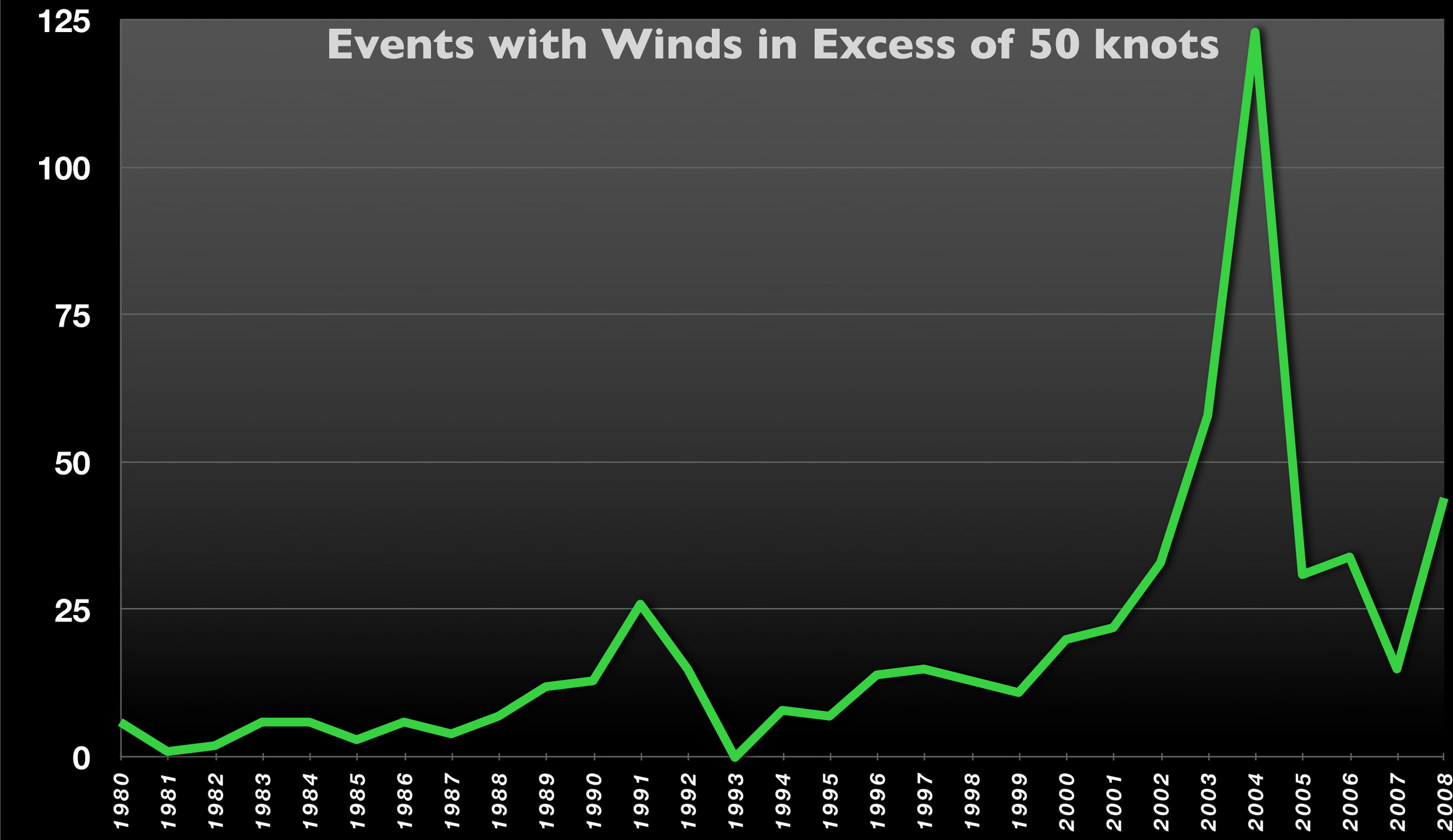
Sheffield, Union of Concerned Scientists, NECIA, 2006

Precipitation Percent Anomaly in MD



Thunderstorm + High Wind Events in MD

1980 - 2008

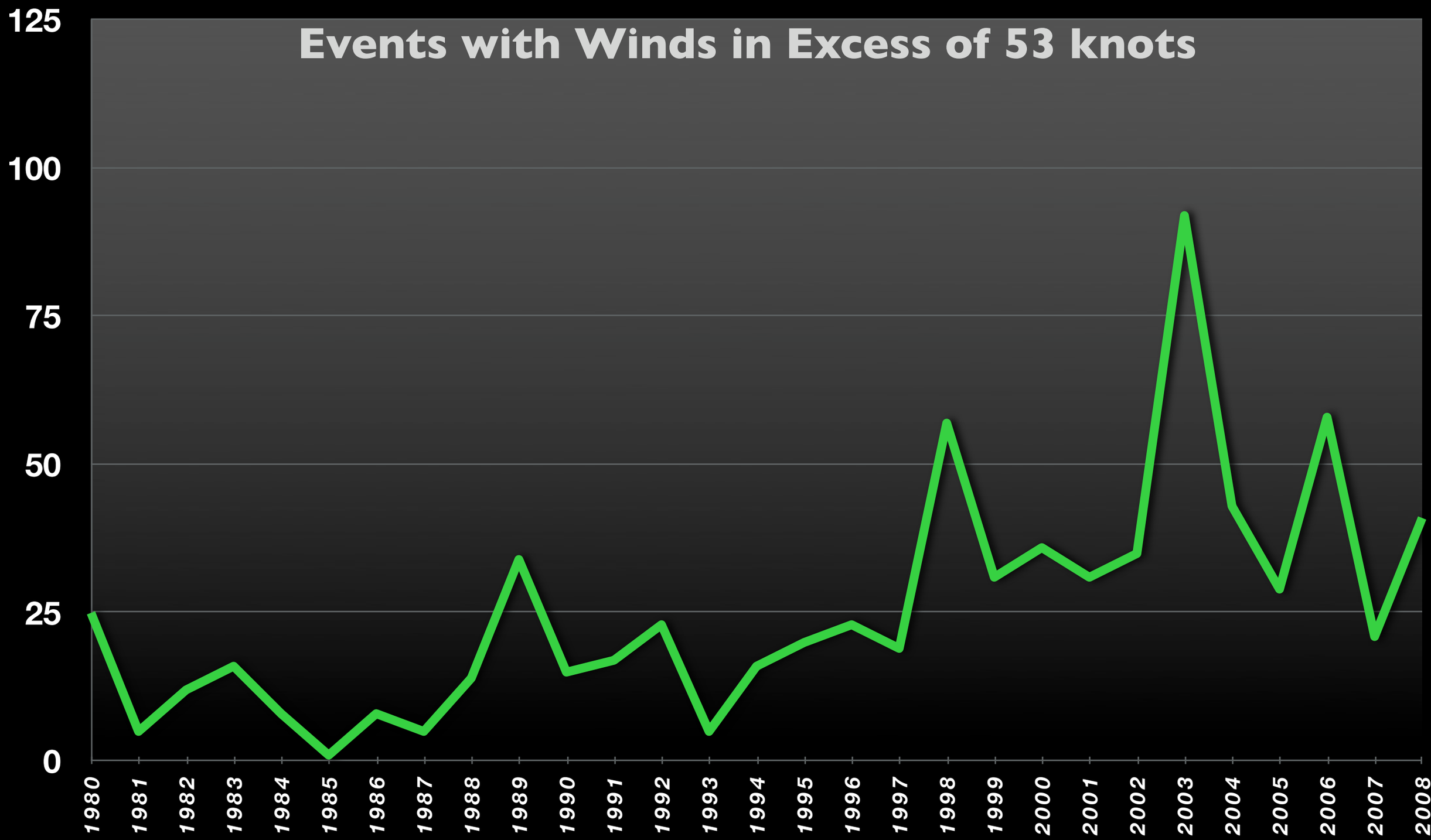


after NOAA Satellite and Information Service:

http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~stormsatlas/

Thunderstorm + High Wind Events in PA

1980 - 2008



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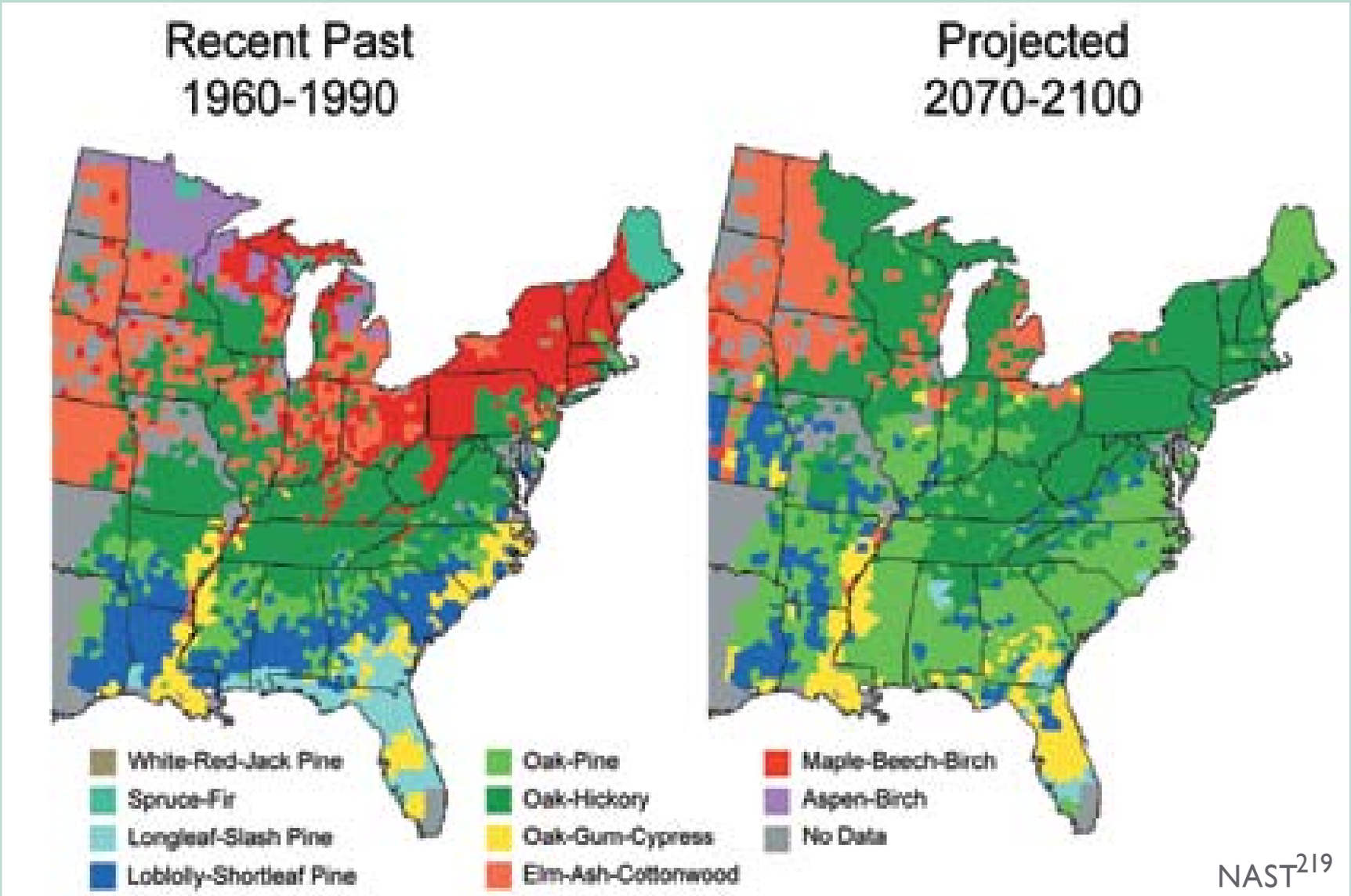
Climate Change Impacts

Eastern US: **Projected** Shifts in Forest Types

Projected Shifts in Forest Types

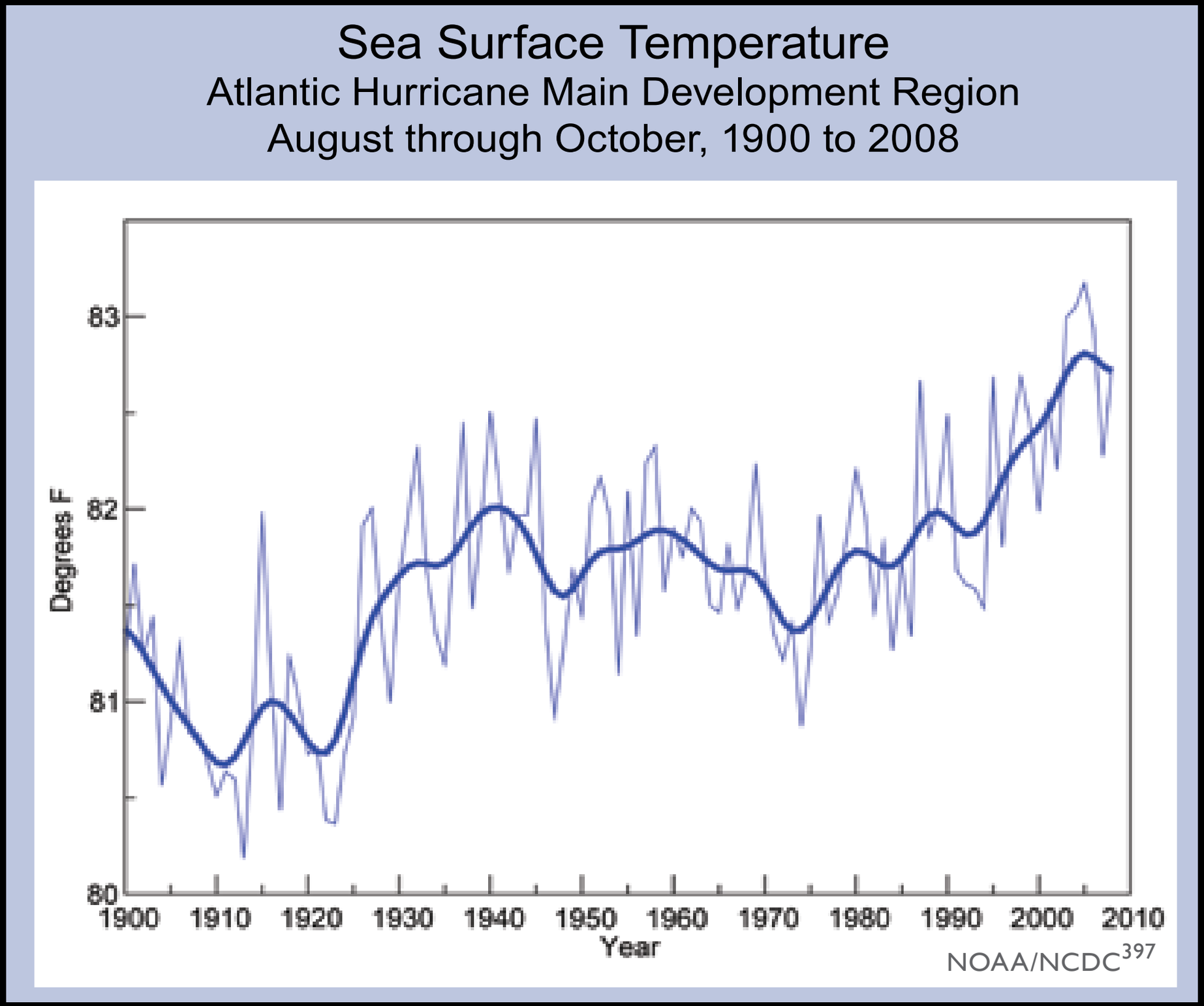


The maps show current and projected forest types. Major changes are projected for many regions. For example, in the Northeast, under a mid-range warming scenario, the currently dominant maple-beech-birch forest type is projected to be completely displaced by other forest types in a warmer future.[243]

Source: Global Climate Change Impacts in the U.S.

Climate Change Impacts

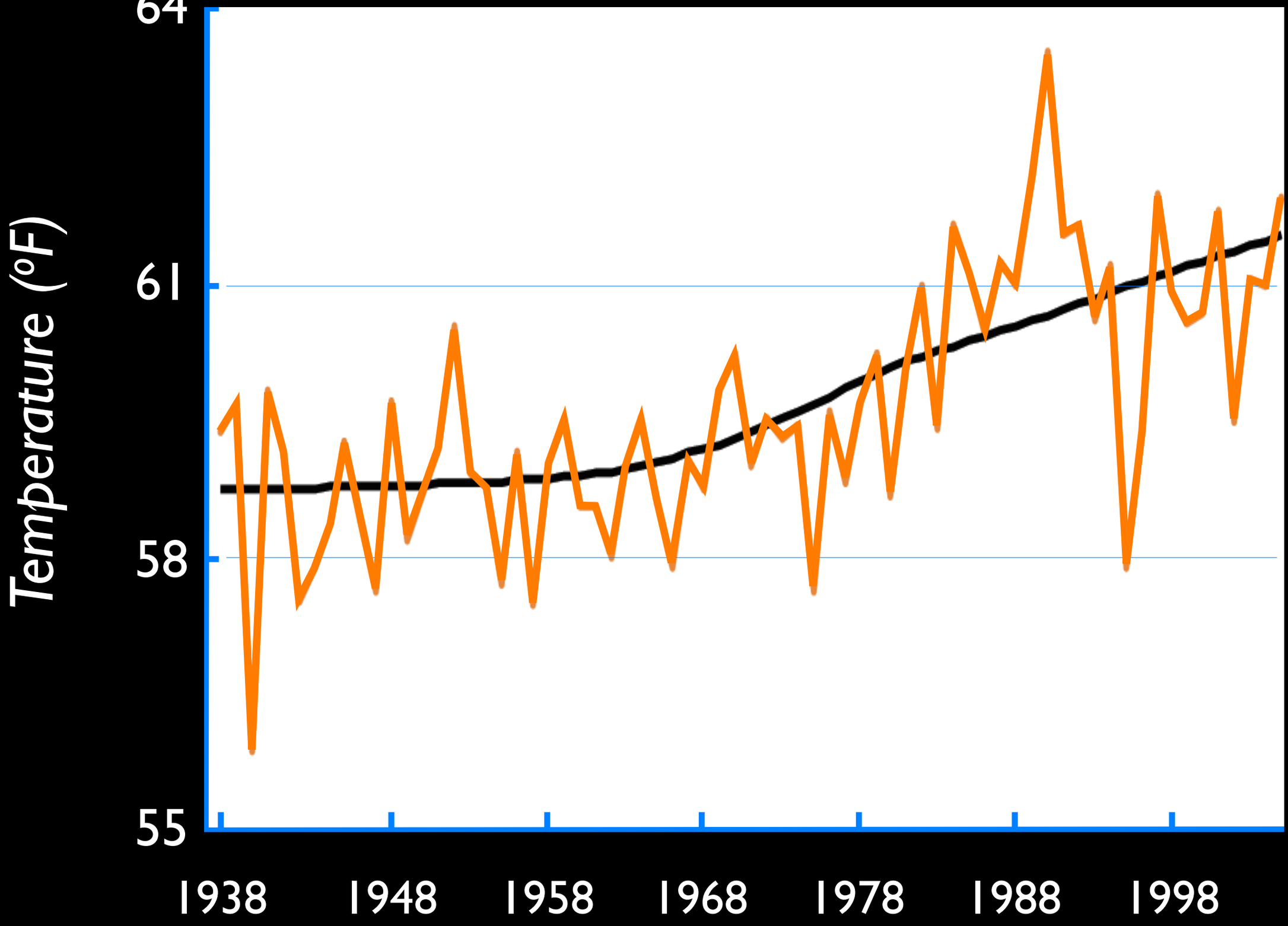
Atlantic Sea Surface Temperature: **Observed**



Source: Global Climate Change Impacts in the U.S.

Chesapeake Bay Temperature

Observed at Solomons, MD



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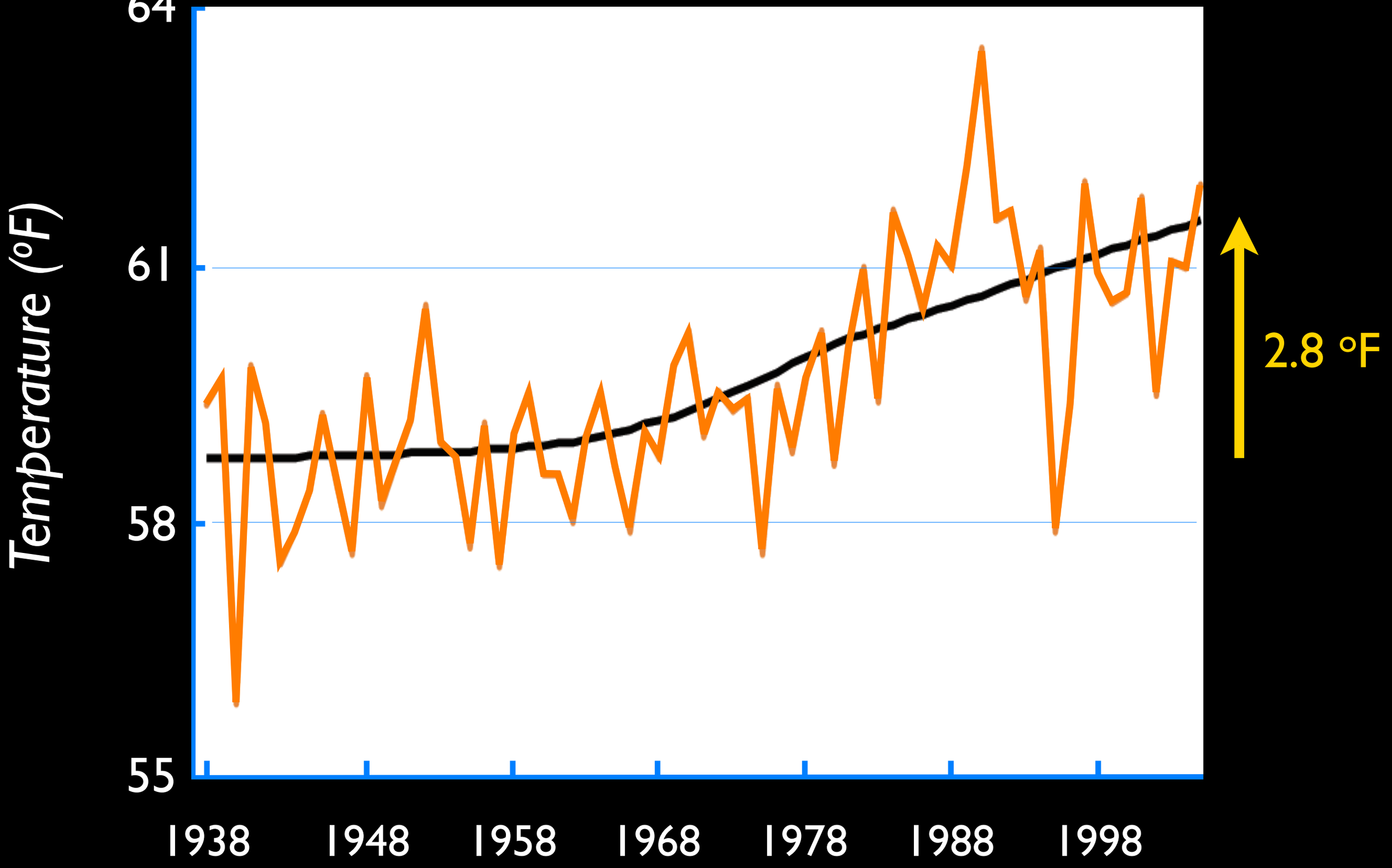
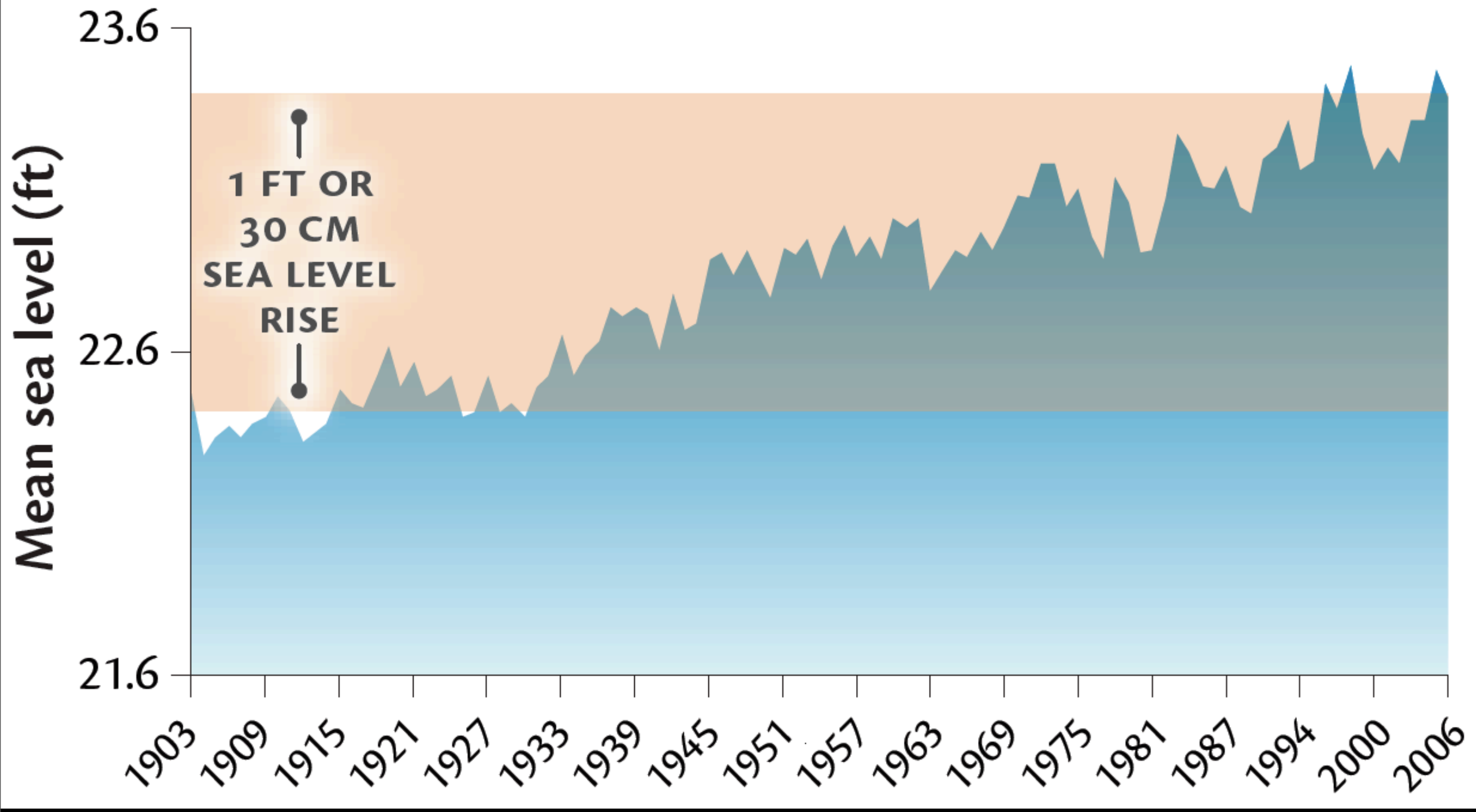


sea level rise

Mean Sea Level Rise in Baltimore
1903 - 2006

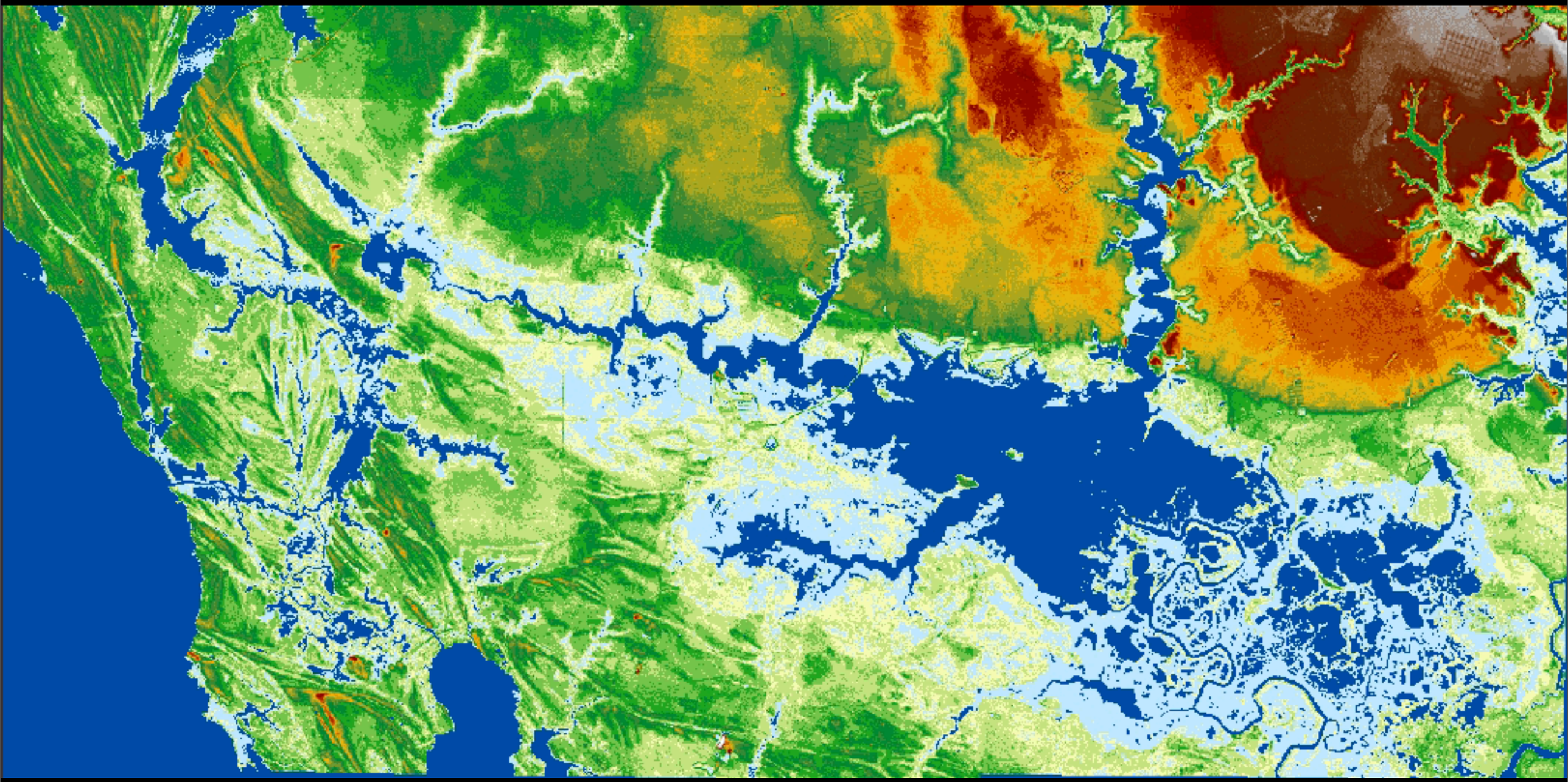


Blackwater National Wildlife Refuge Area

Baseline: **3** mm rise /year

2002

2000 2050 2100



Open Water Intertidal Marsh High Marsh

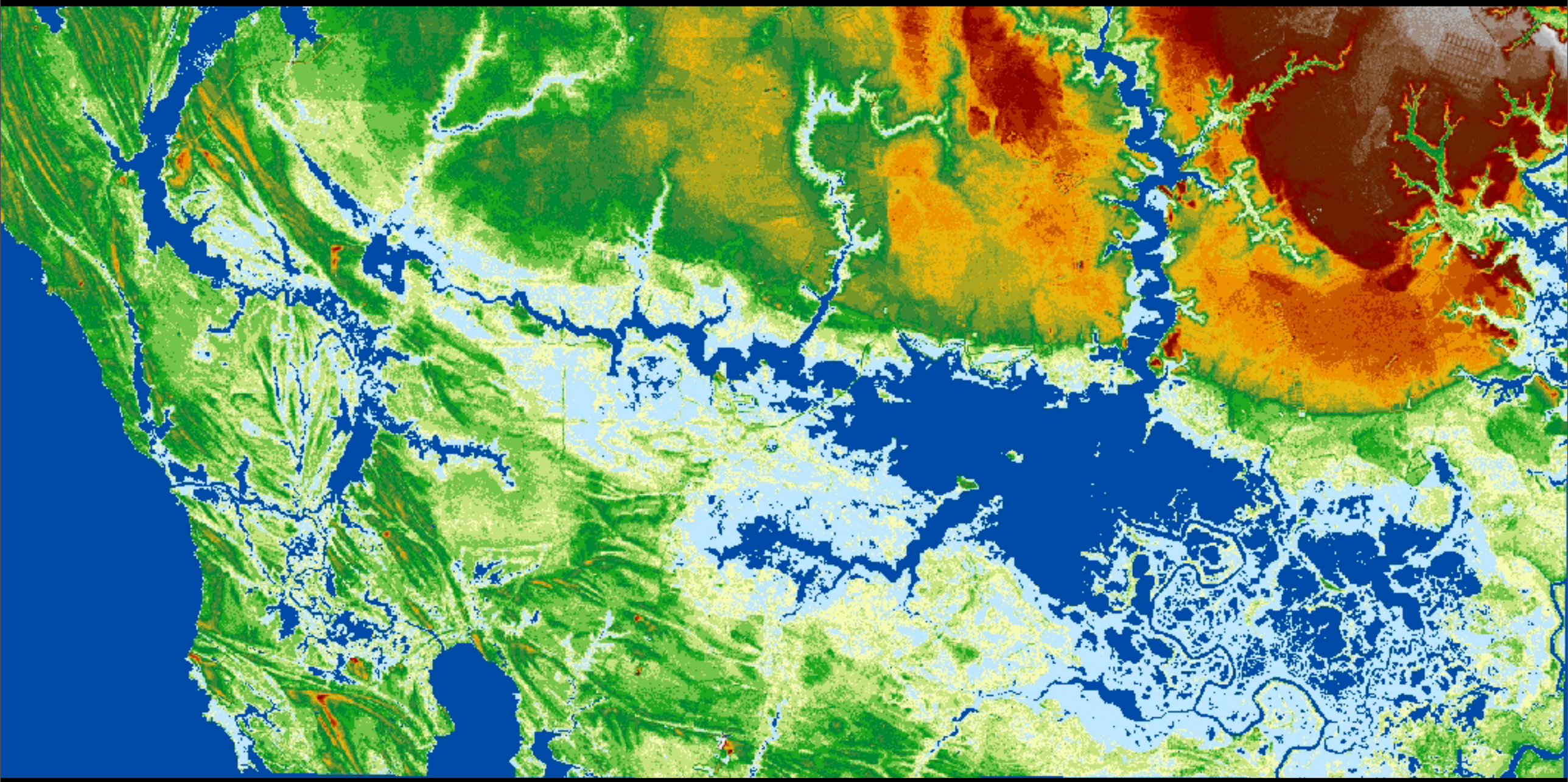
USGS

Blackwater National Wildlife Refuge Area

Baseline: **3** mm rise /year

2010

2000 2050 2100



Open Water Intertidal Marsh High Marsh

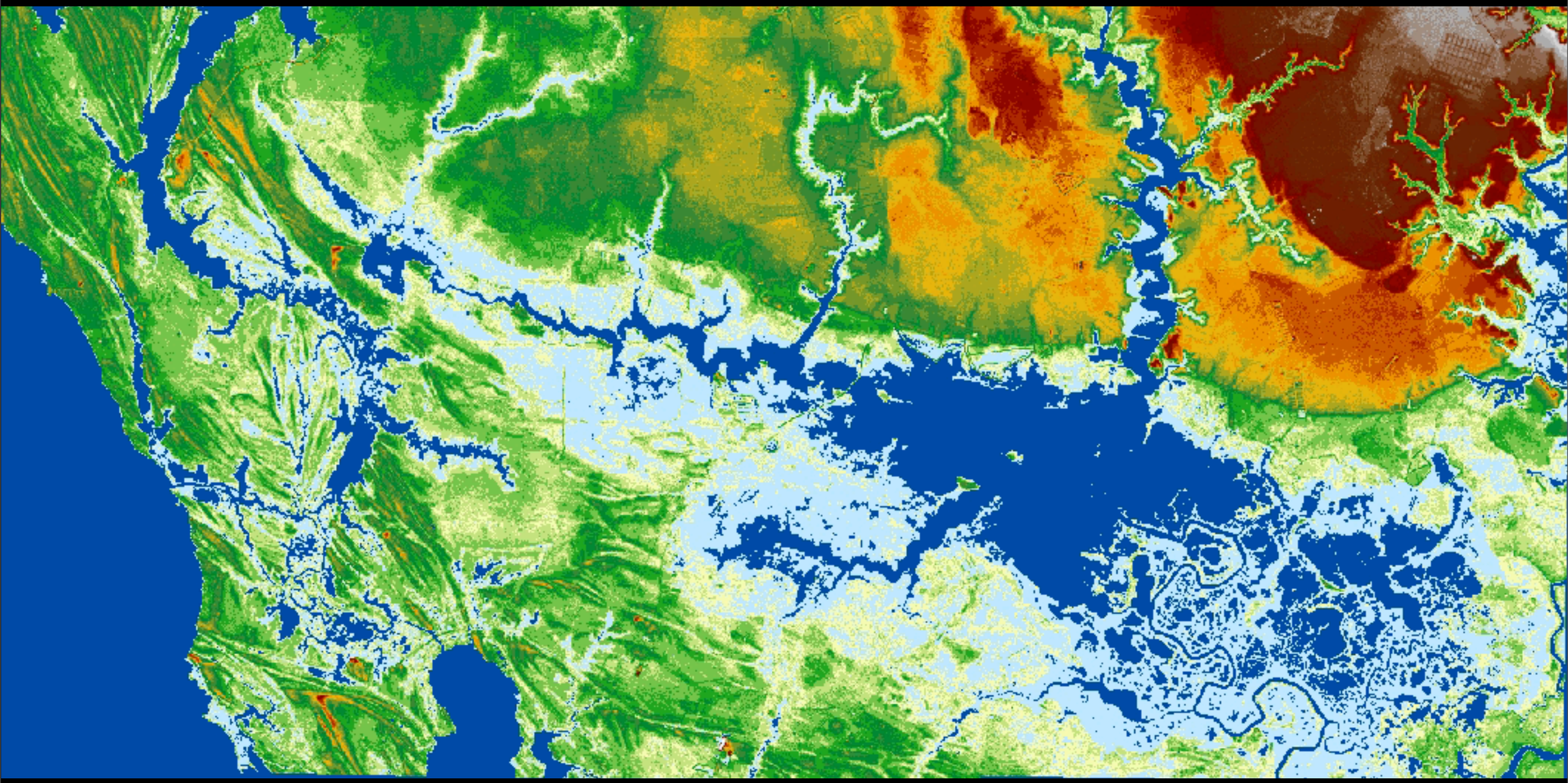
USGS

Blackwater National Wildlife Refuge Area

Baseline: **3** mm rise /year

2020

2000 2050 2100



Open Water Intertidal Marsh High Marsh

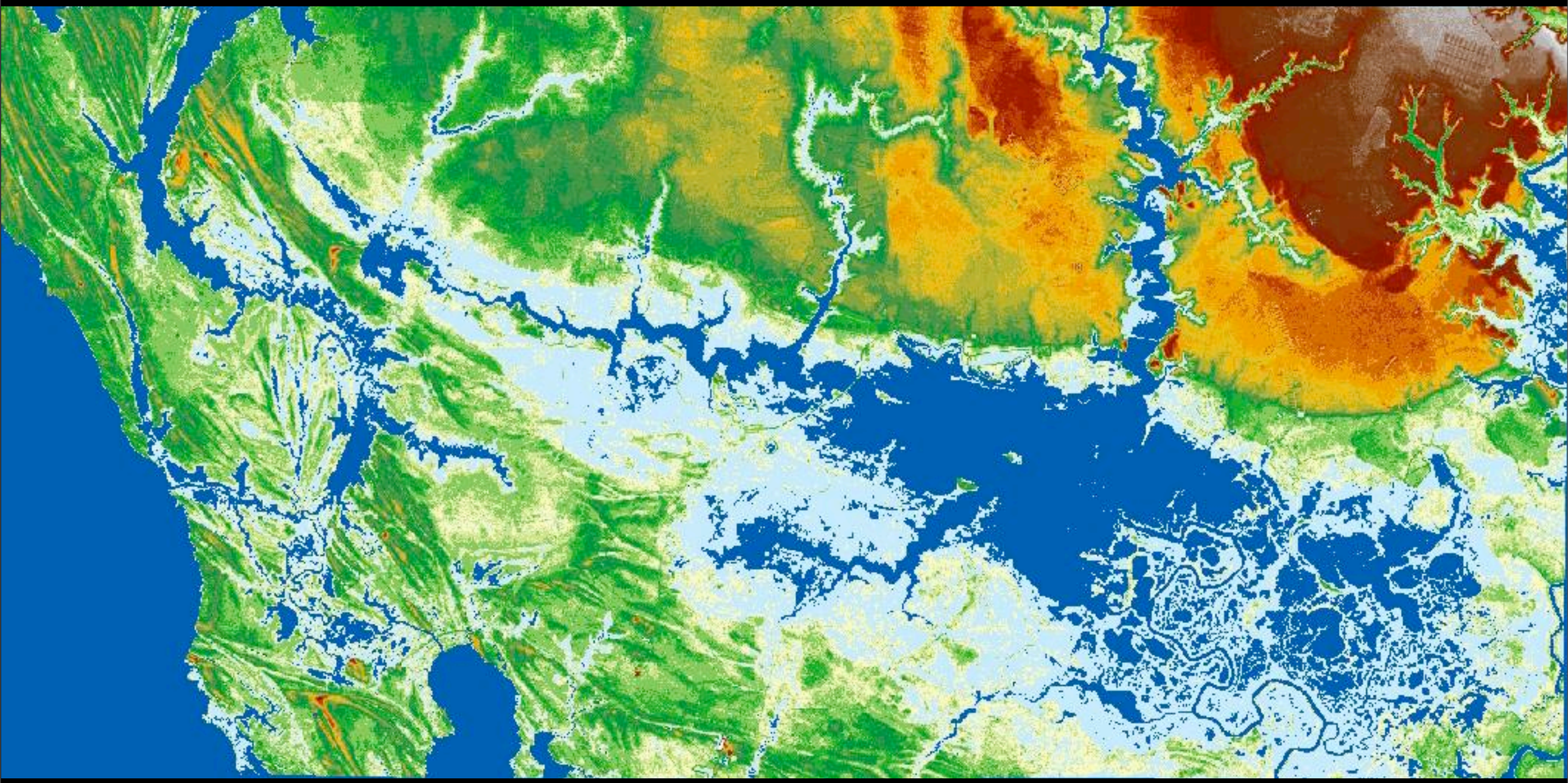
USGS

Blackwater National Wildlife Refuge Area

Baseline: **3** mm rise /year

2030

2000 2050 2100



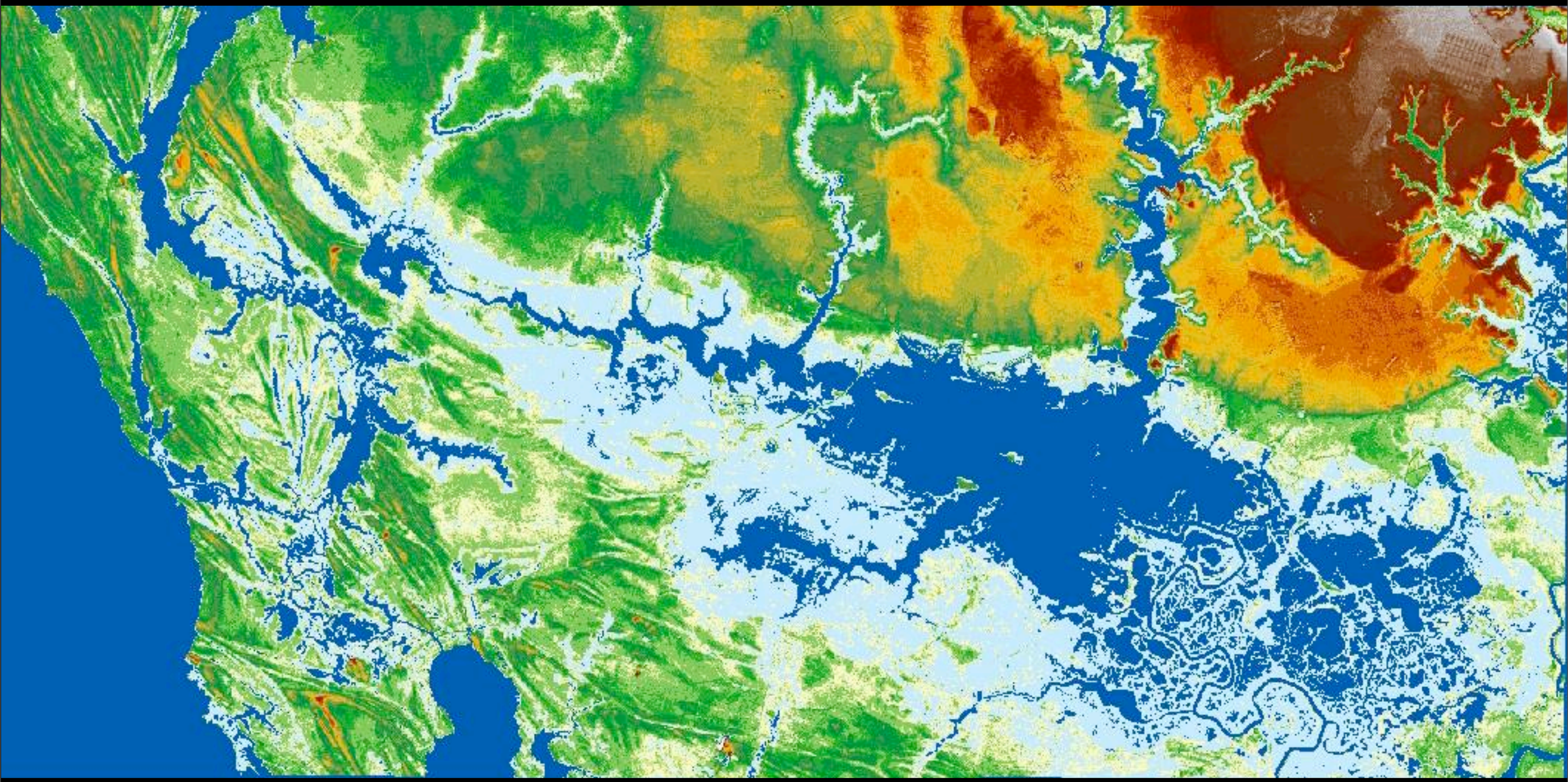
Open Water Intertidal Marsh High Marsh

Blackwater National Wildlife Refuge Area

Baseline: **3** mm rise /year

2040

2000 2050 2100



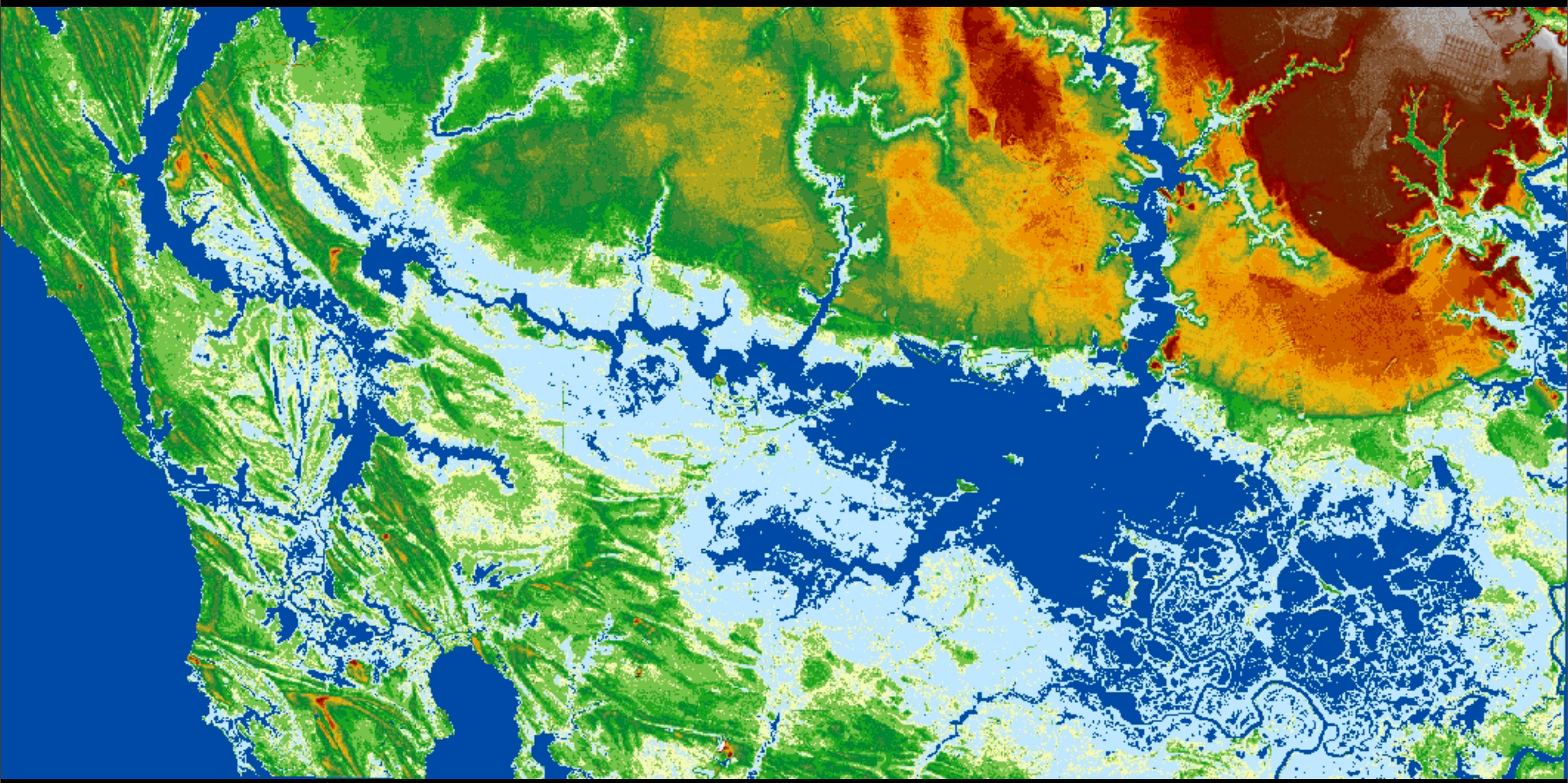
Open Water Intertidal Marsh High Marsh

Blackwater National Wildlife Refuge Area

Baseline: **3** mm rise /year

2050

2000 2050 2100



Open Water Intertidal Marsh High Marsh

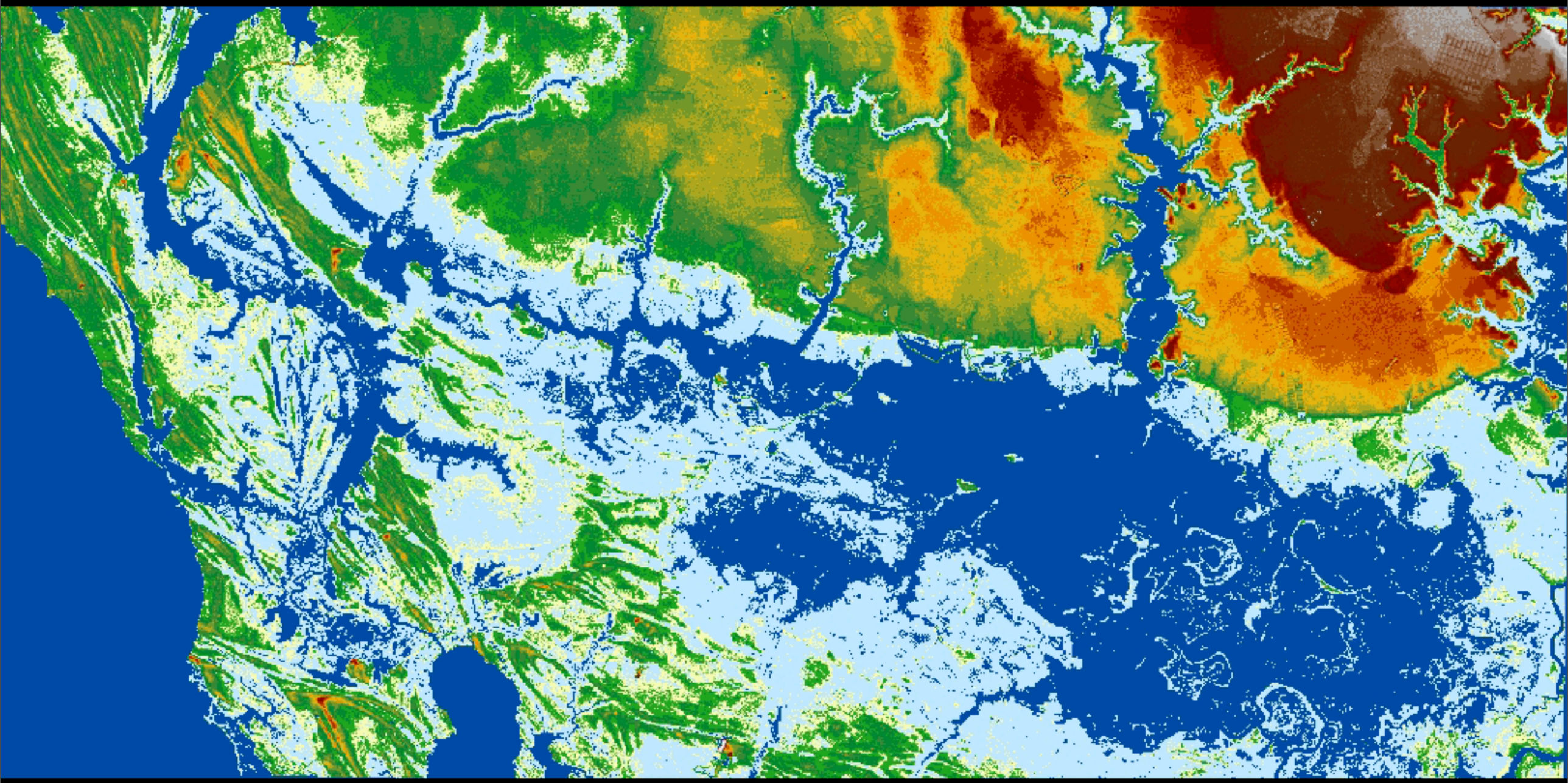
USGS

Blackwater National Wildlife Refuge Area

Baseline: **3** mm rise /year

2100

2000 2050 2100



Open Water Intertidal Marsh High Marsh

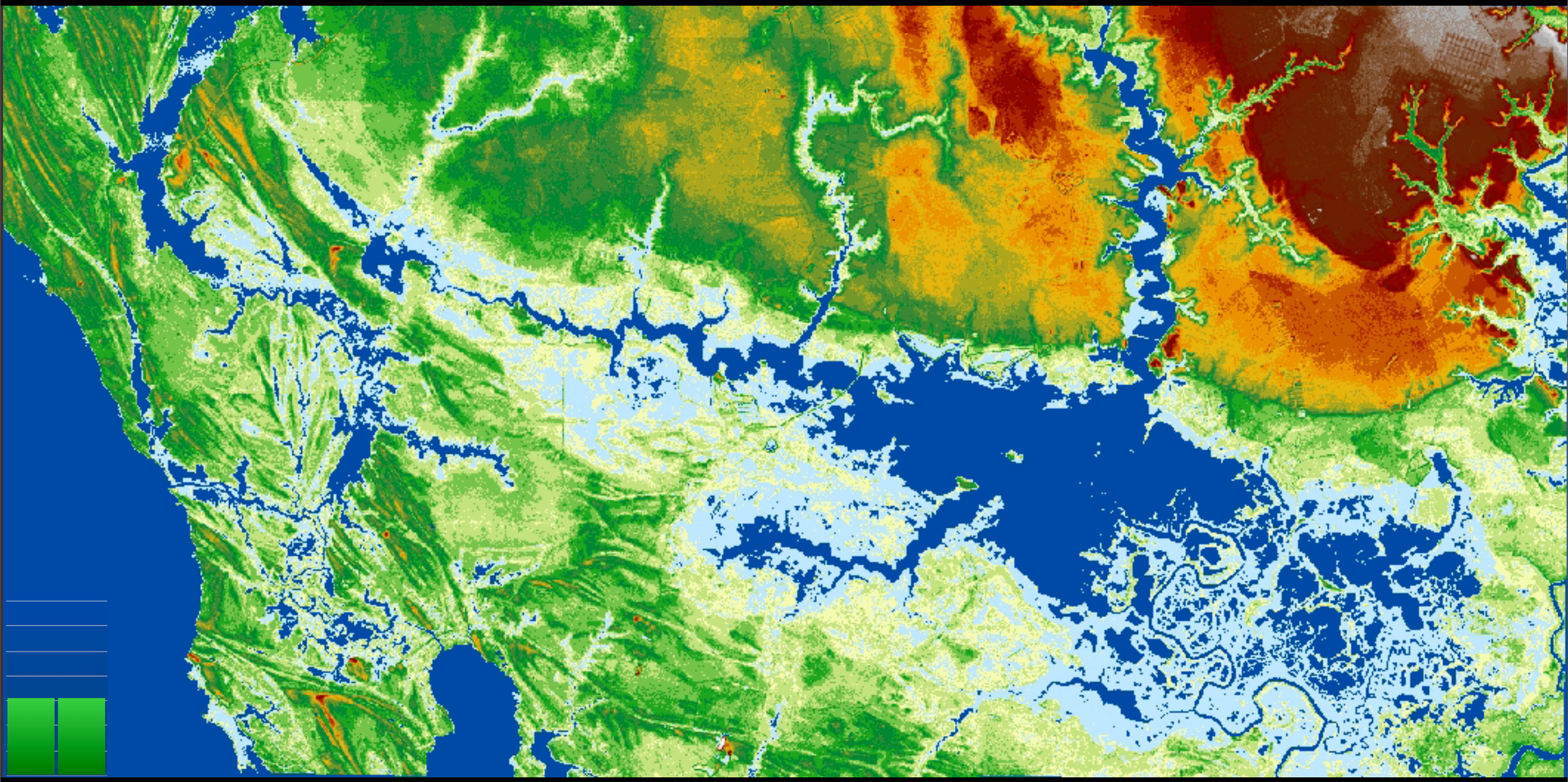
USGS

Blackwater National Wildlife Refuge Area

IPCC projection, average case scenario, **3** mm rise / year

2002

2000 2050 2100



BL

IPCC

Open Water

Intertidal Marsh

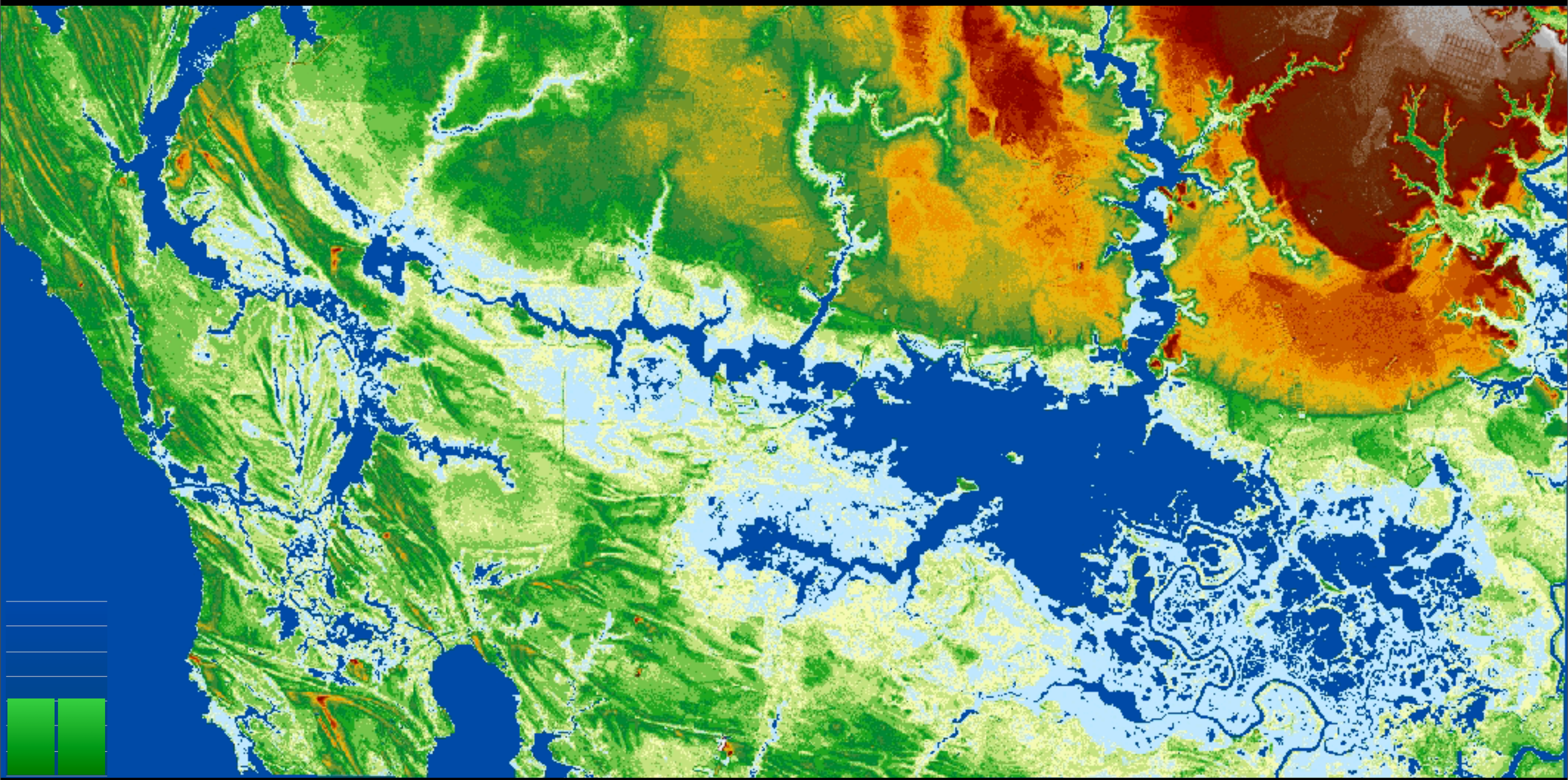
High Marsh

Blackwater National Wildlife Refuge Area

IPCC projection, average case scenario, **3** mm rise / year

2010

2000 2050 2100



BL

IPCC

Open Water Intertidal Marsh High Marsh

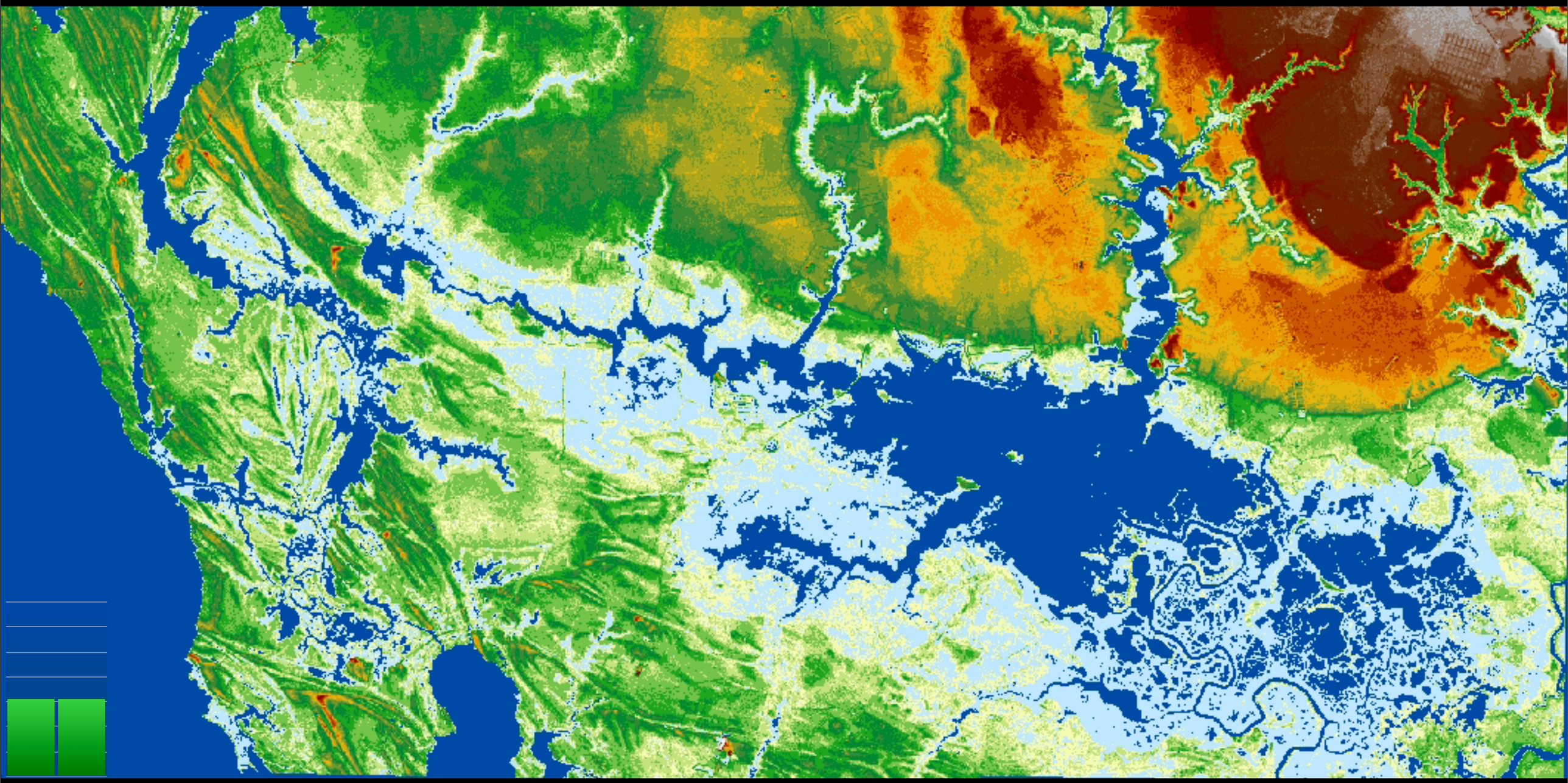
USGS

Blackwater National Wildlife Refuge Area

IPCC projection, average case scenario, **3** mm rise / year

2020

2000 2050 2100



BL

IPCC

Open Water

Intertidal Marsh

High Marsh

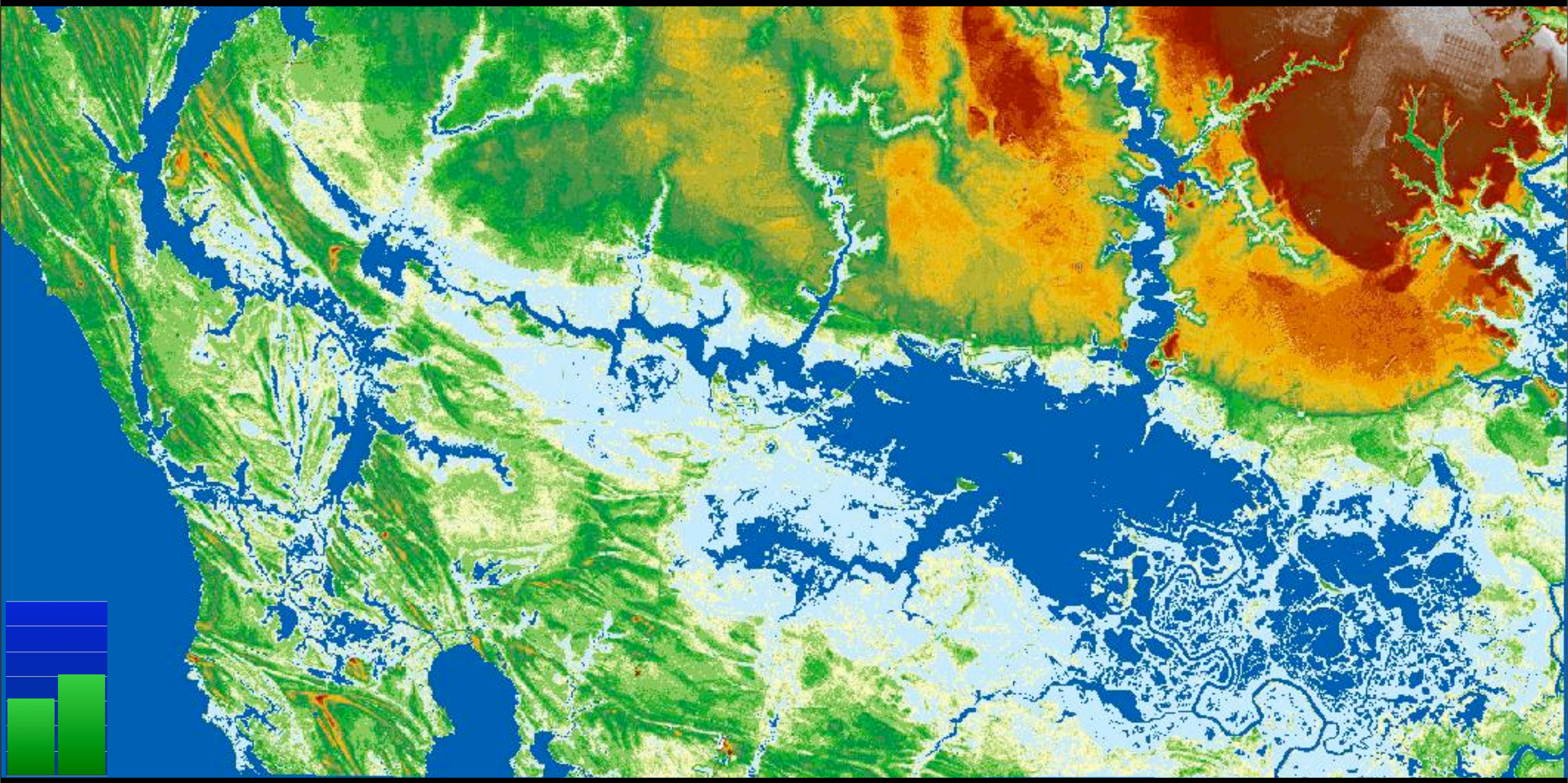
USGS

Blackwater National Wildlife Refuge Area

IPCC projection, average case scenario, **4** mm rise / year

2030

2000 2050 2100



BL IPCC

Open Water Intertidal Marsh High Marsh

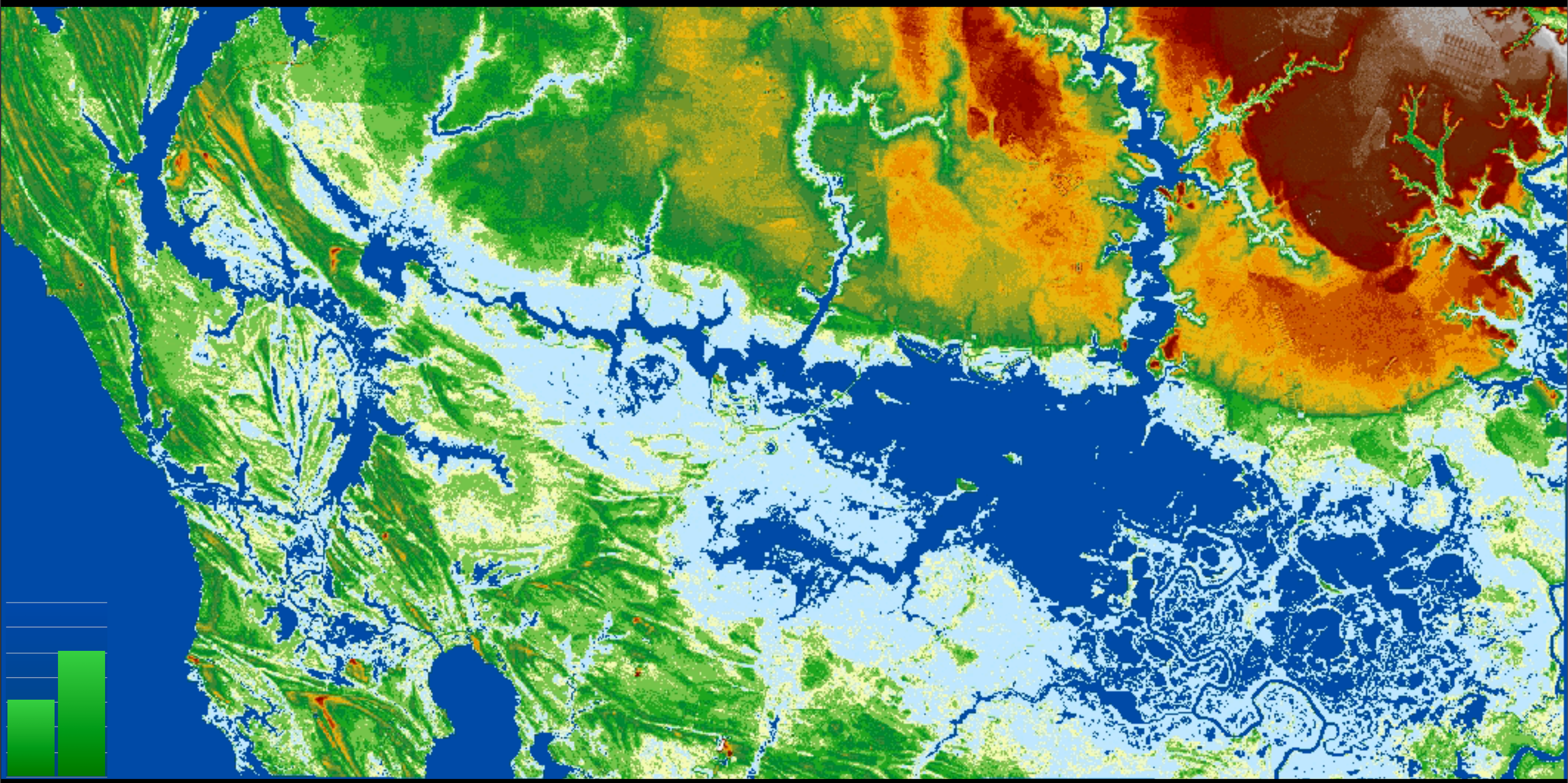
USGS

Blackwater National Wildlife Refuge Area

IPCC projection, average case scenario, **5** mm rise / year

2040

2000 2050 2100



BL IPCC

Open Water Intertidal Marsh High Marsh

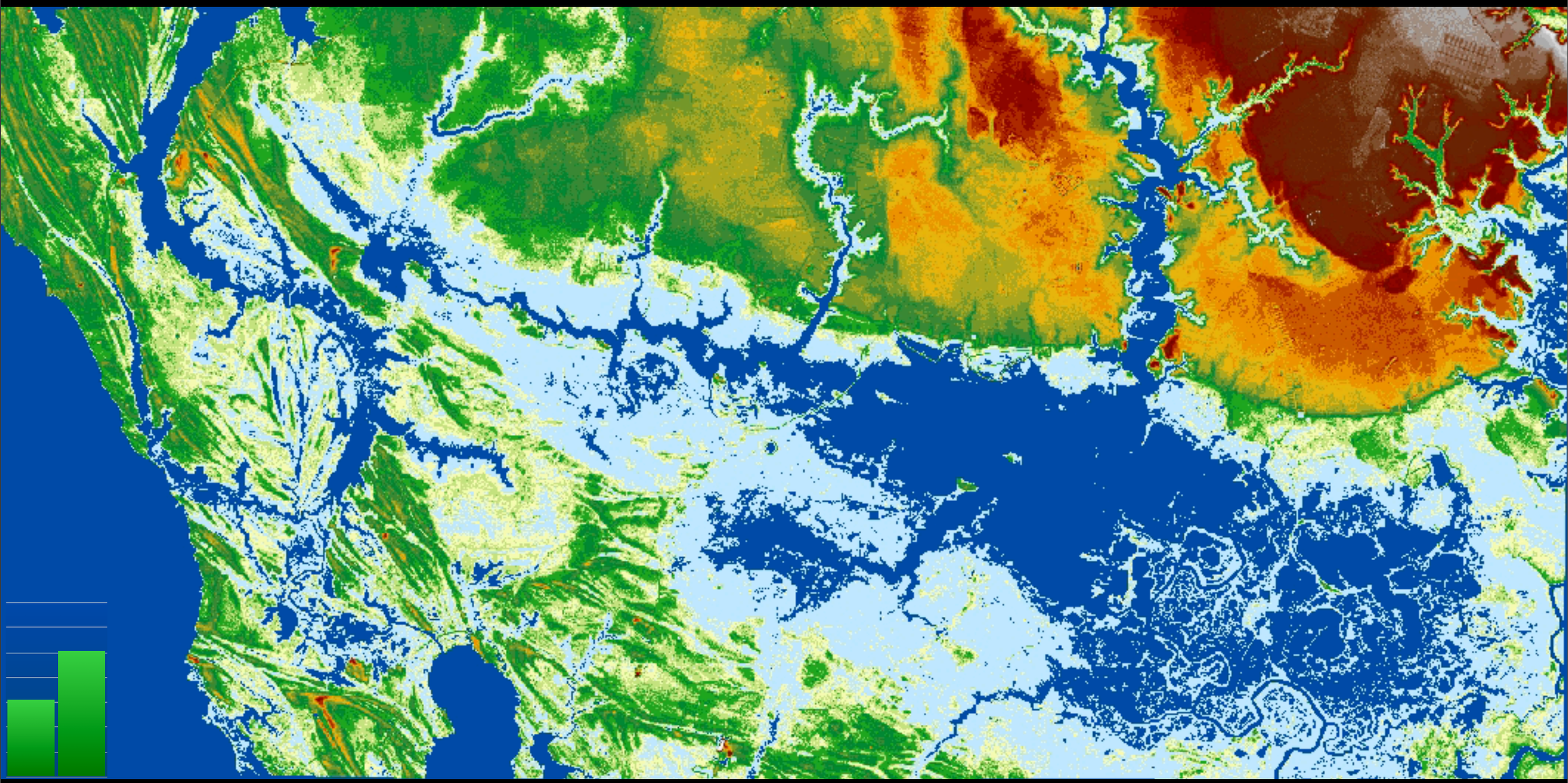
USGS

Blackwater National Wildlife Refuge Area

IPCC projection, average case scenario, **5** mm rise / year

2050

2000 — 2050 — 2100



BL

IPCC

Open Water

Intertidal Marsh

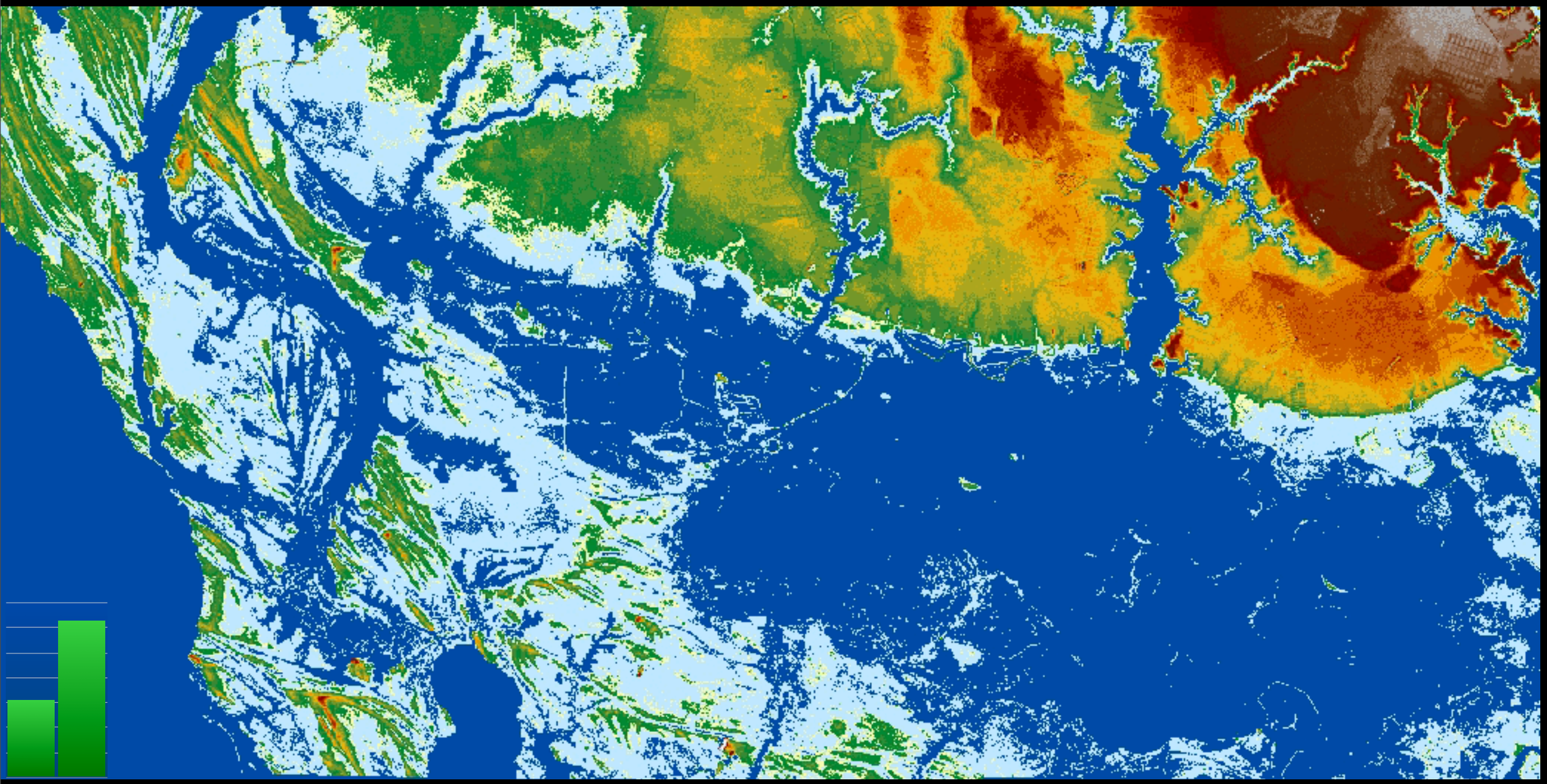
High Marsh

Blackwater National Wildlife Refuge Area

IPCC projection, average case scenario, **6.2** mm rise / year

2100

2000 2050 2100



BL IPCC

Open Water Intertidal Marsh High Marsh

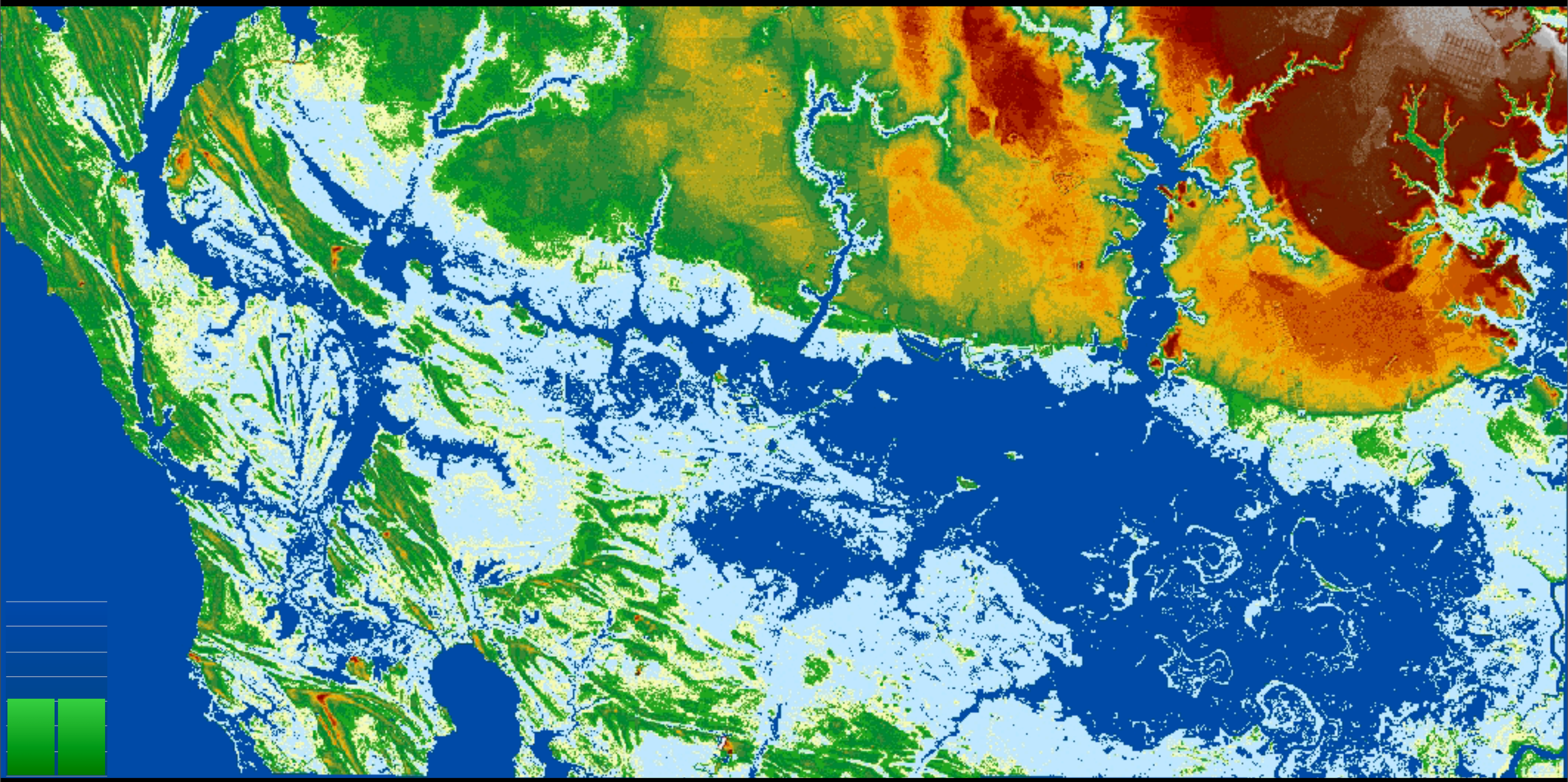
USGS

Blackwater National Wildlife Refuge Area

Baseline: **3** mm rise /year

2100

2000 2050 2100



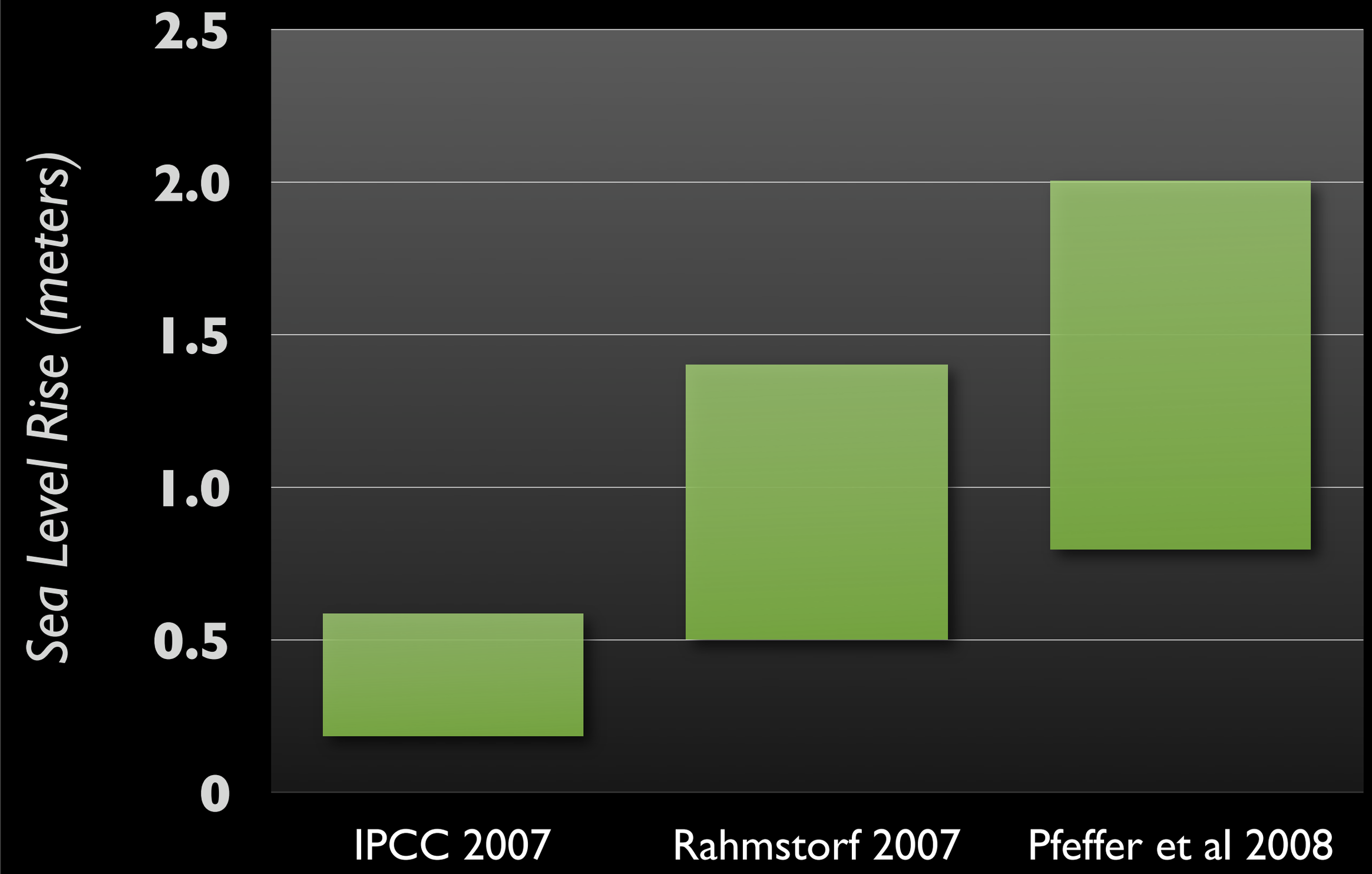
BL

IPCC

Open Water Intertidal Marsh High Marsh

Estimates of Sea Level Rise are Rising

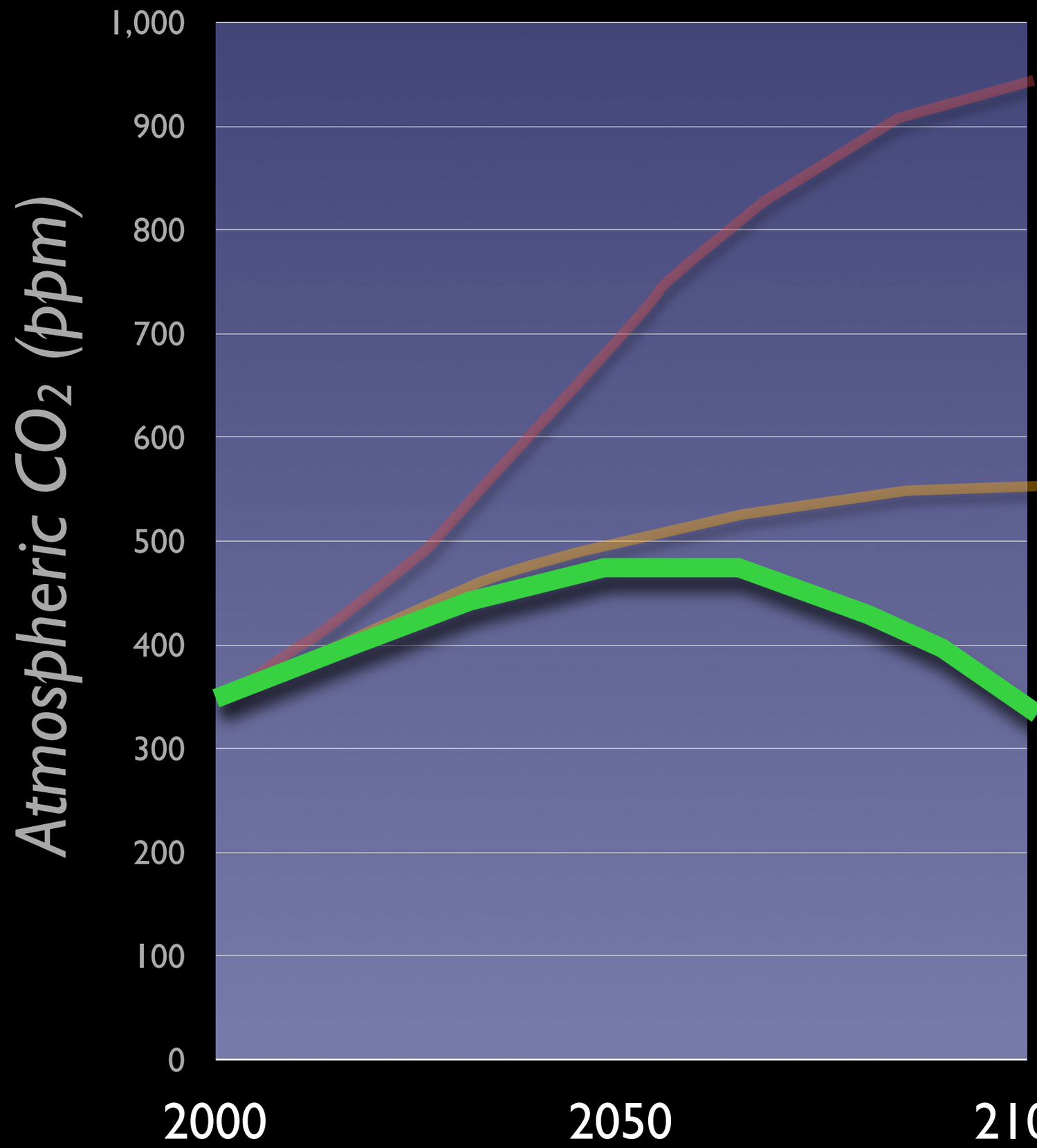
Range of Estimates by 2100



After: pewclimate.org; Science Brief 2, June 2009

the conservation meta-solution

3 Scenarios for Future Emissions



Business as Usual *(UCS High)*

Stabilization at Higher Level *(UCS Low)*

Stabilization + Restoration *(Hansen: Coal Phaseout with CCS)*

The Core Problem

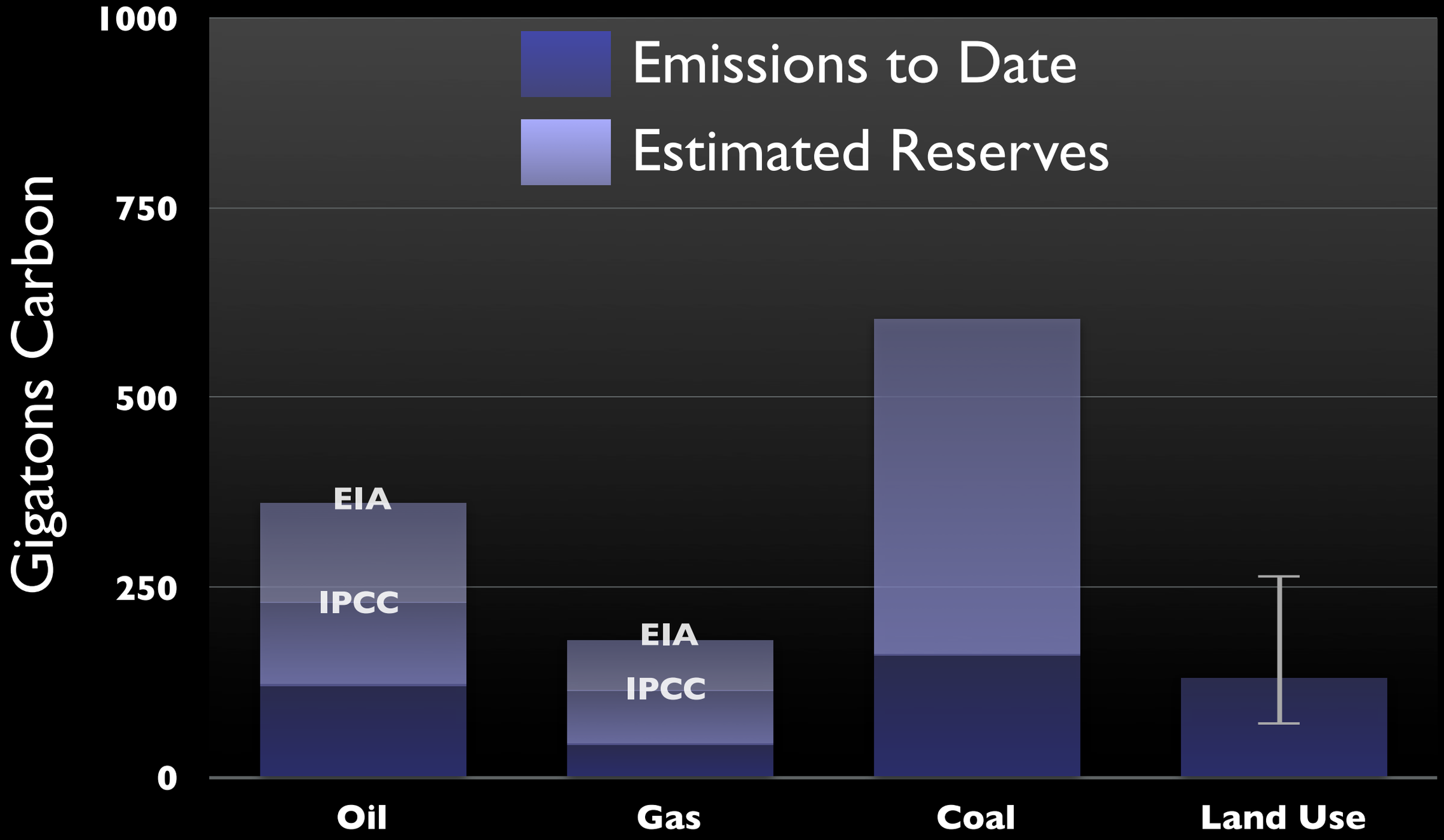
According to James Hansen,

Chief Climate Scientist, NASA Goddard Institute for Space Studies

"If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced from its current **385 ppm** to at most **350 ppm.**"

Fossil Fuel + Net Land Use Emissions

The "Geophysical Boundary Condition"



James Hansen et al; April, 2008

And the Conservation Solution . . .

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"An initial 350 ppm CO2 target may be achievable **by phasing out coal use** except where CO2 is captured and **adopting agricultural and forestry practices that sequester carbon**.

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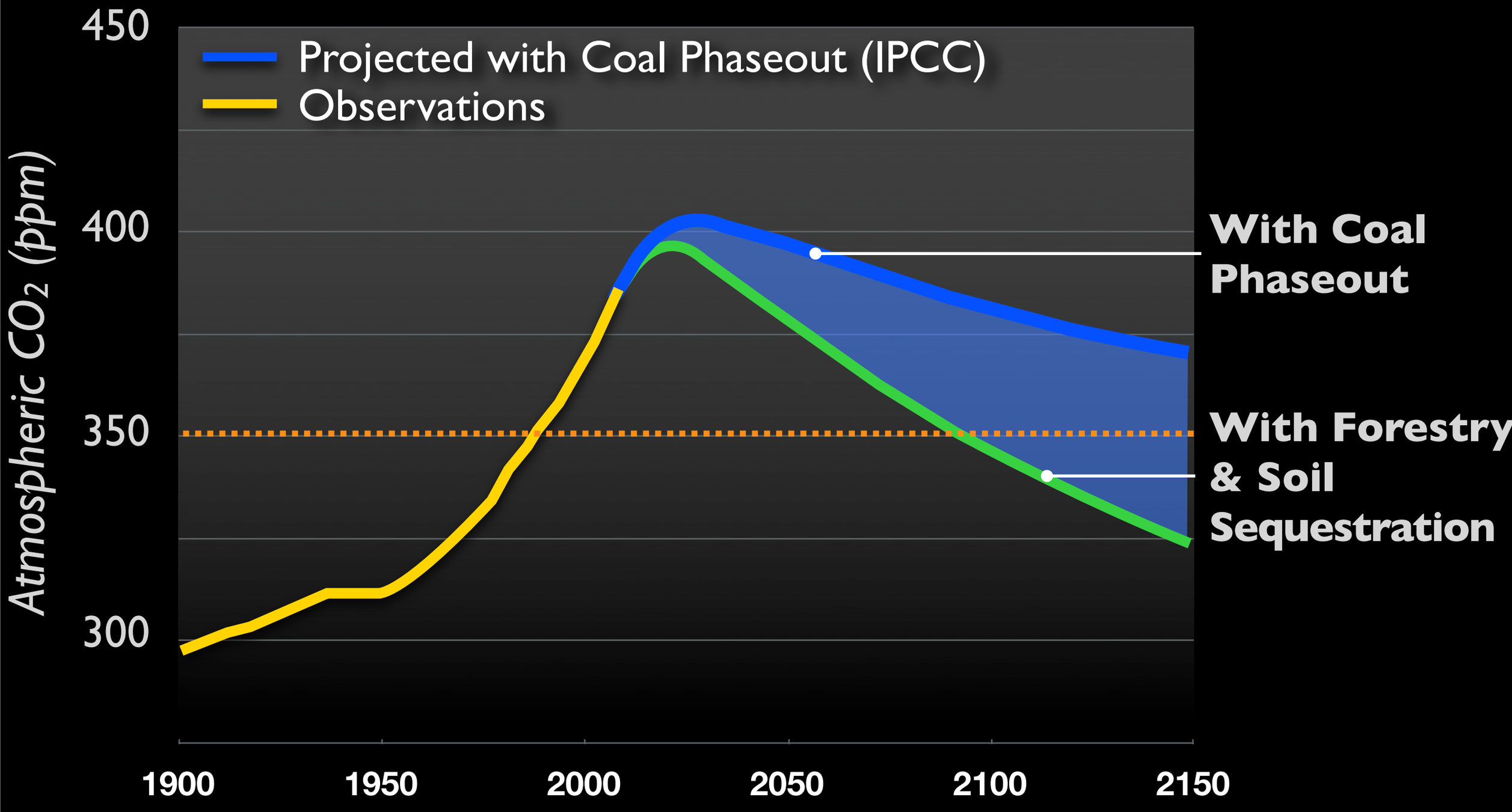
James Hansen et al; *Target Atmospheric Co2: Where Should Humanity Aim?* April, 2008

CO_2 with Coal Phaseout by 2030

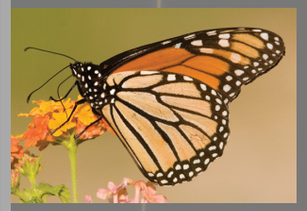


After: James Hansen et al; *Target Atmospheric Co2: Where Should Humanity Aim?* April, 2008

nature adapting

US Climate Change Science Program

Products 4.3 & 4.4, June 2008

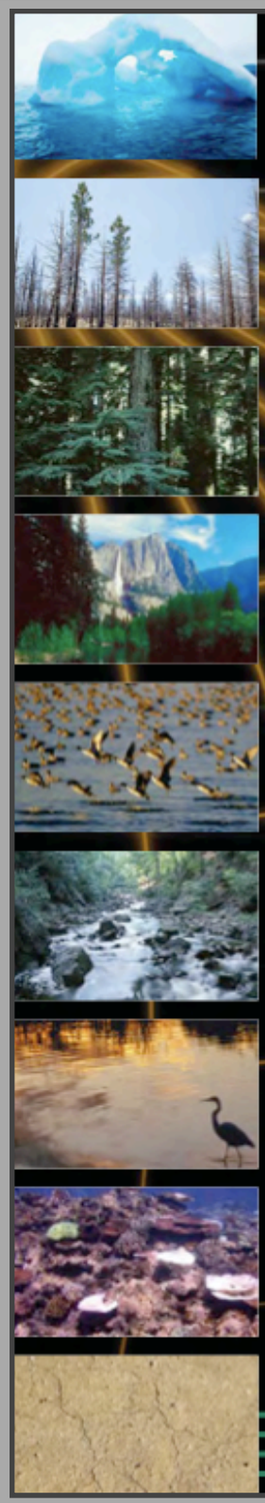


The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States

Synthesis and Assessment Product 4.3
Report by the U.S. Climate Change Science Program
and the Subcommittee on Global Change Research

CONVENING LEAD AUTHORS:
Peter Backlund, Anthony Janetos, and David Schimel

MANAGING EDITOR:
Margaret Walsh



Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources

U.S. Climate Change Science Program
And the Subcommittee on Global Change Research

Final Report, Synthesis and Assessment Product 4.4

June 2008

Wildlife Responses: (observed)

- **866** peer reviewed articles
- **1598** species studied
- **60% had shifts in distribution or phenology** over 20 and 140 year timeframes

Source: CCSP, The Effects of Climate Change on Agriculture...

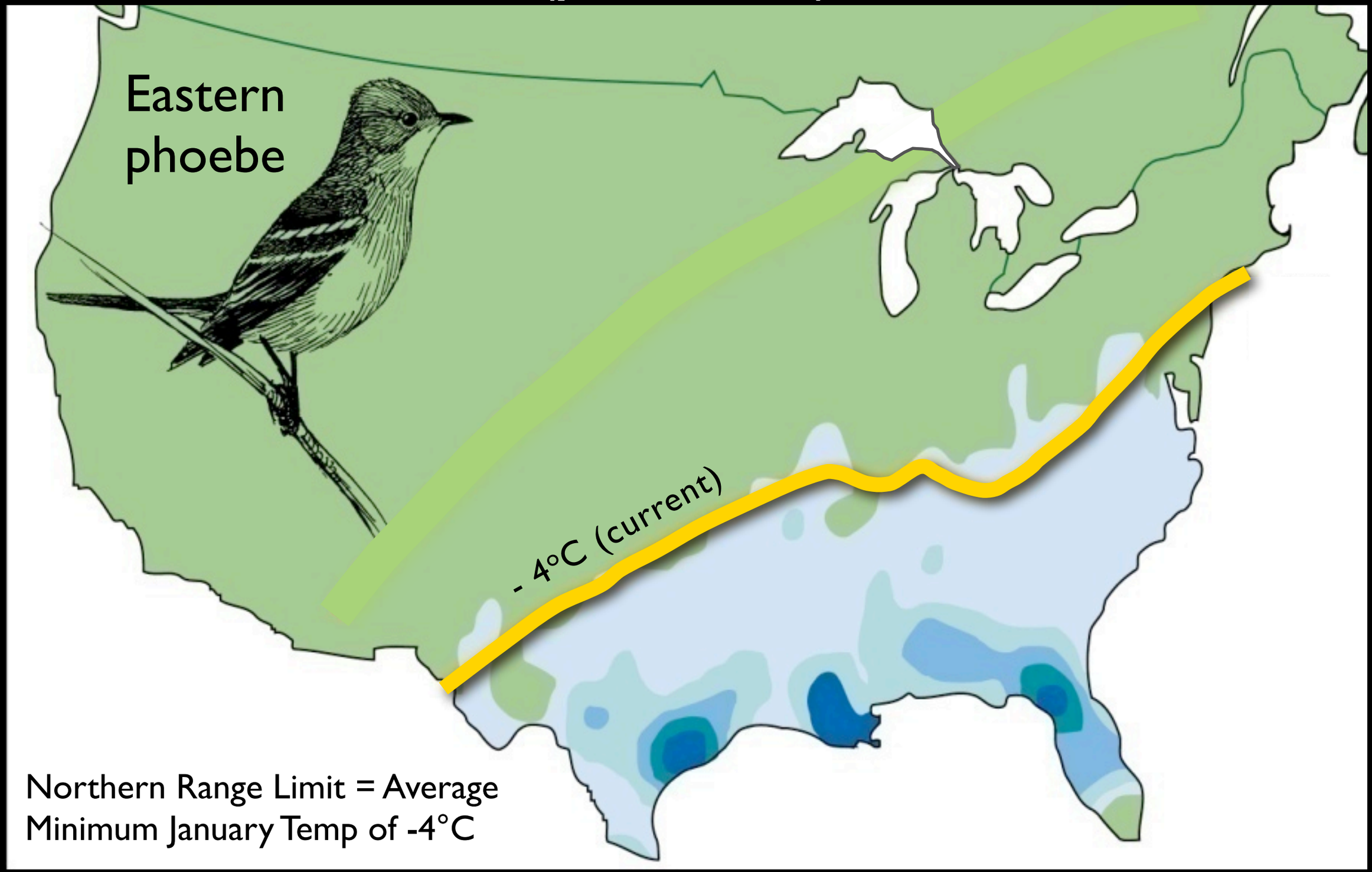
Wildlife Responses: Distributions
(observed)

- The northern ranges of many species are temperature-limited

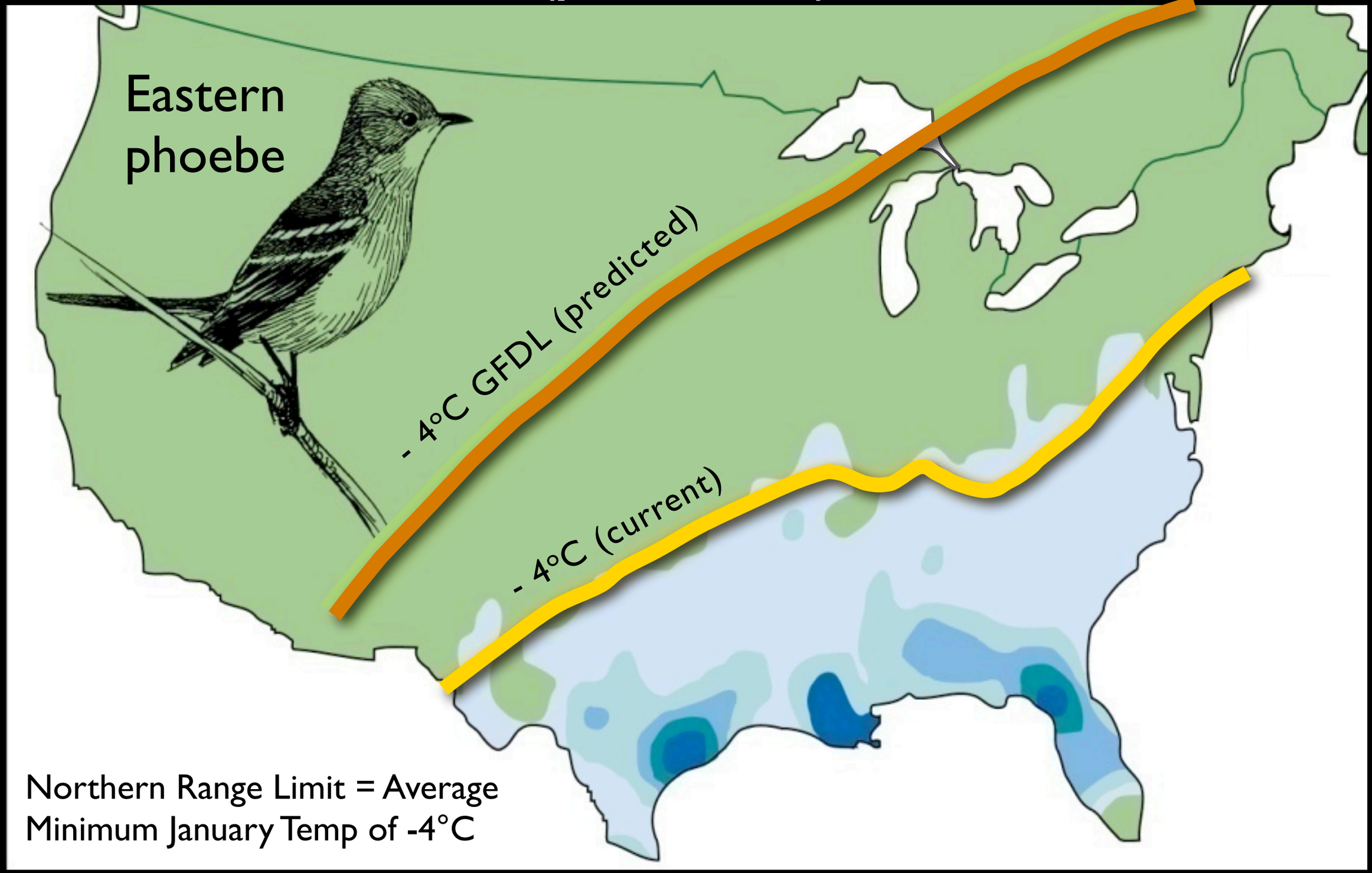
- Vast majority of species studied are already shifting ranges generally to the north, and very few to the south

- Models predict this effect will continue as warming increases

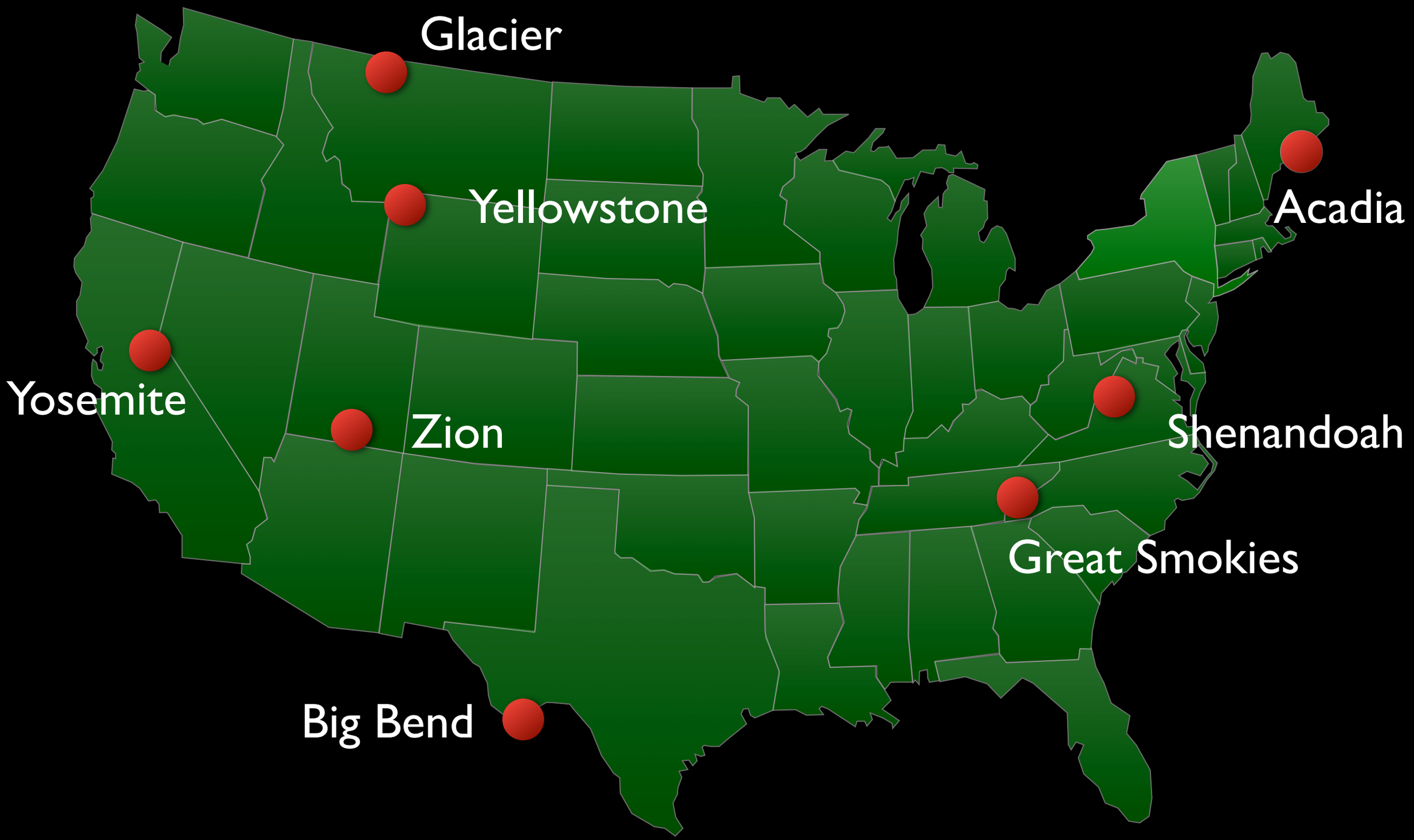
Wildlife Responses: Distributions (predicted)



Wildlife Responses: Distributions (predicted)

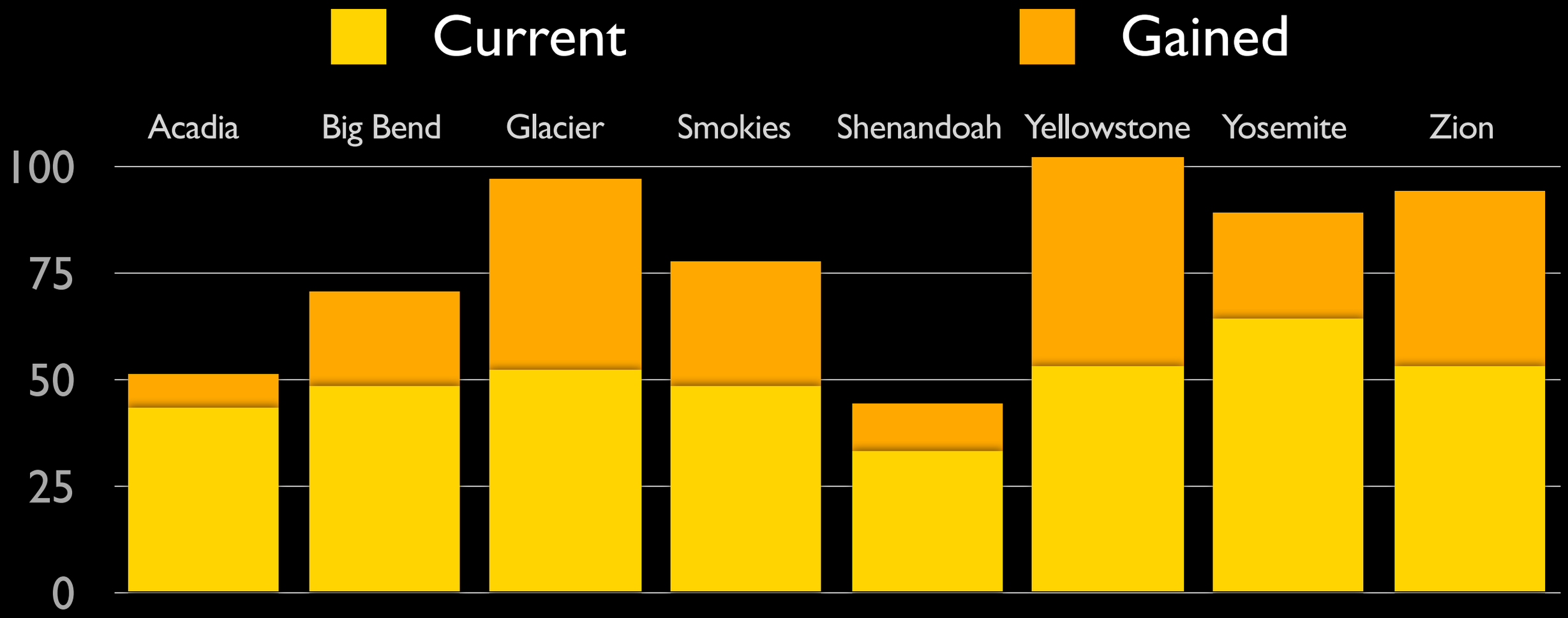


Predicting Future Mammal Responses



C. E. Burns et al

Total Mammal Species (Predicted)



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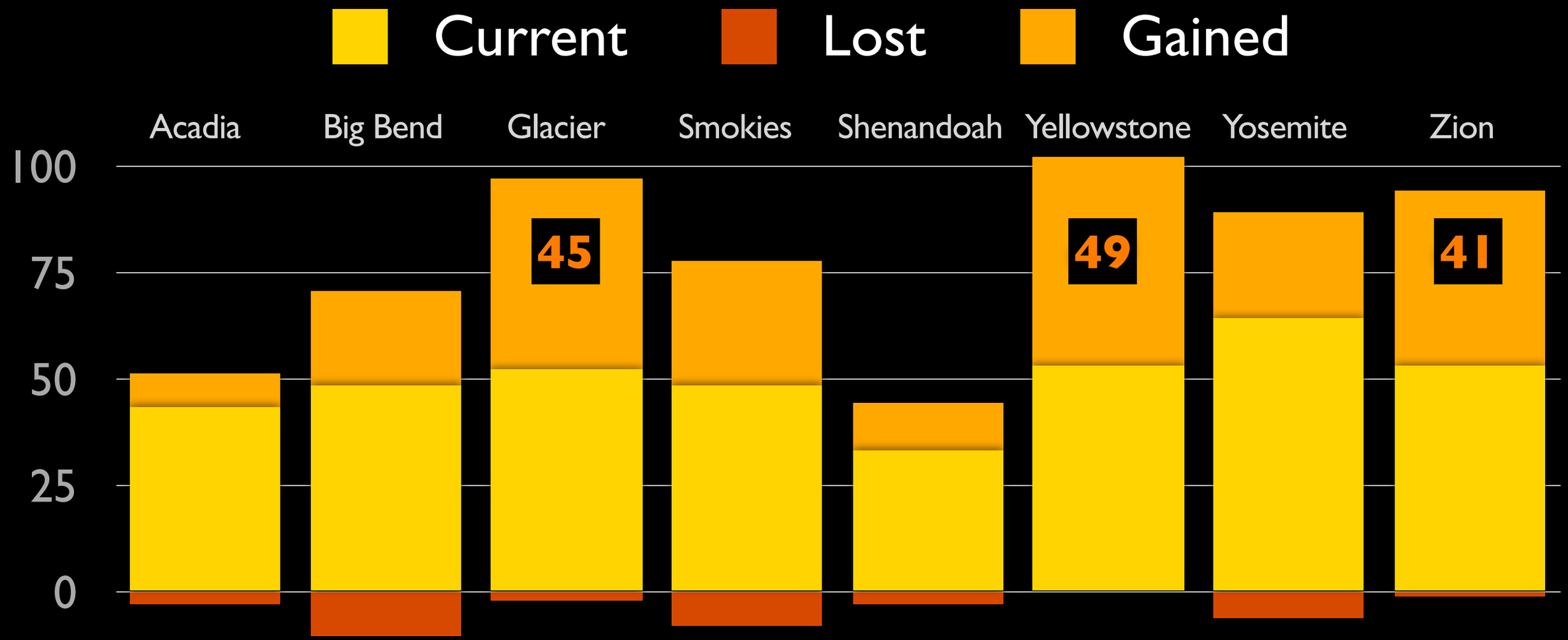

Key Points

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But they will also gain new species *if we manage landscapes successfully to permit range shifts*

Species composition will be significantly altered, as will interactions between species (new predator/prey, competitive, host/parasite interactions)

Successful management requires facilitating wildlife responses to climate change and working together at large spatial scales to do so

After the Last Ice Age

Ecosystems Disassembled + Reassembled into New Systems

Alder

Alnus glatinosa

Oaks

Quercus spp.

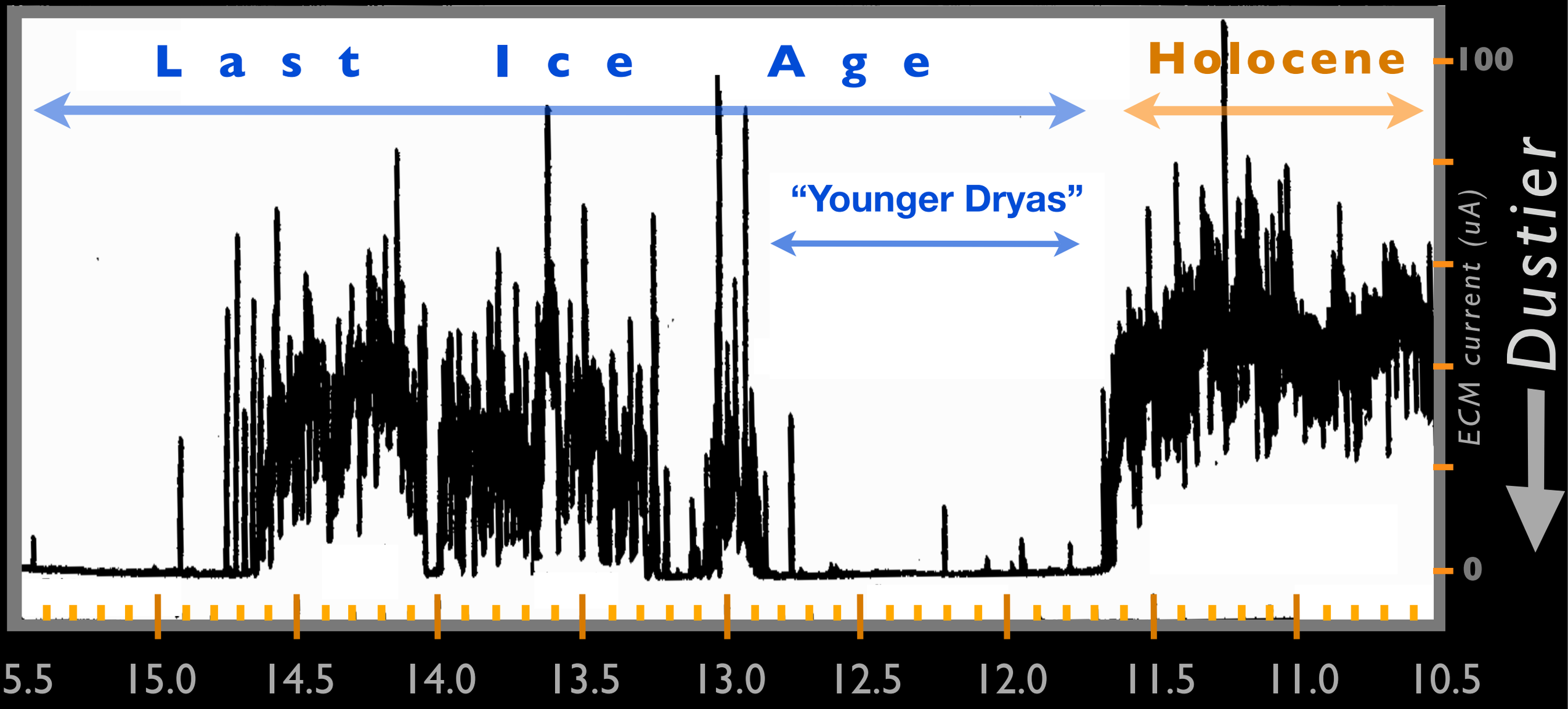
Source: G.M. Hewitt and Nichols, R.A. 2005

A Common View

"It's not that ecosystems will shift in ways that we haven't seen in our past history. It's *the rate* at which we are forcing the shifts to occur…200 years vs. 18,000 years.

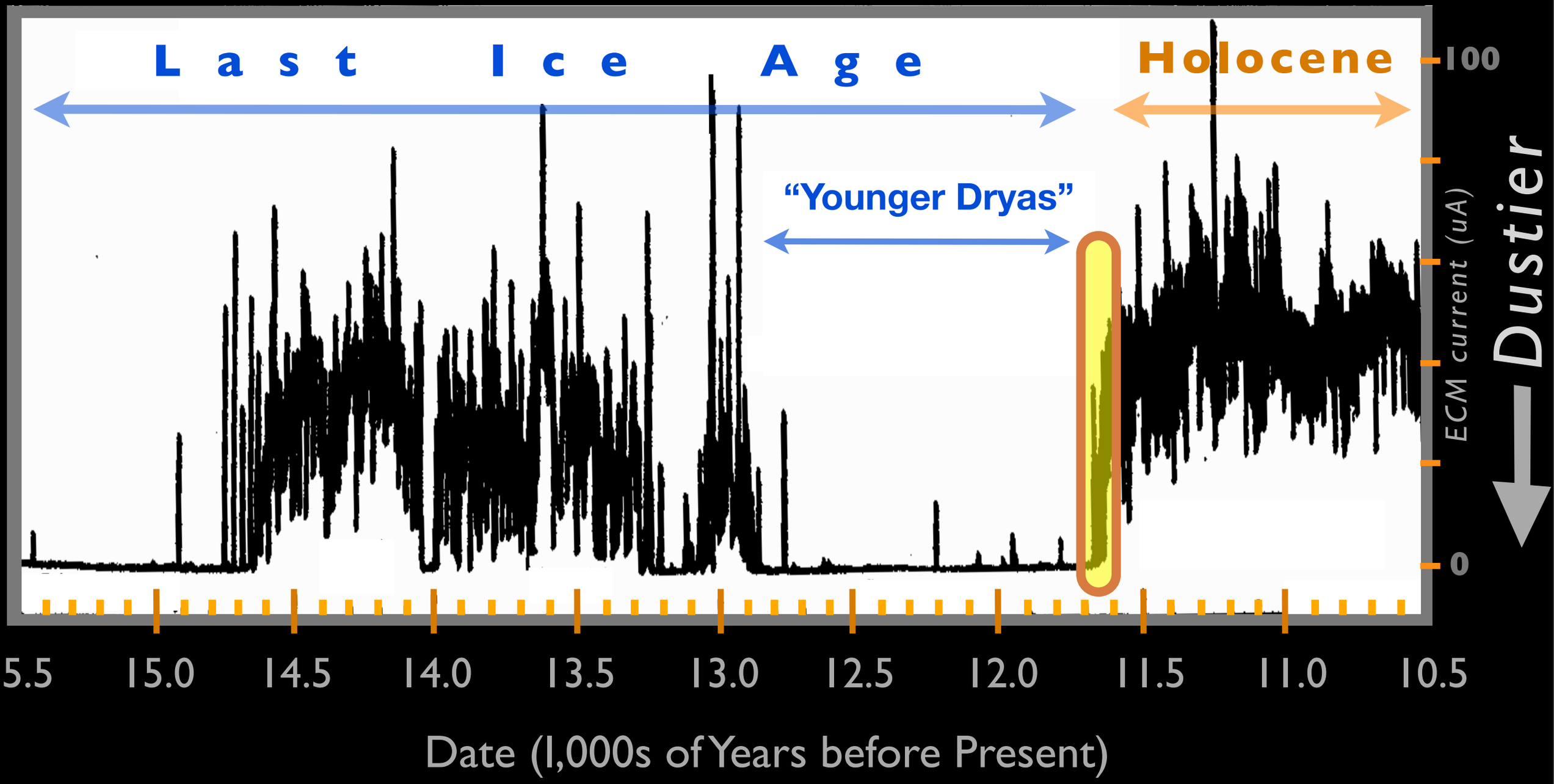
"Many species will not be able to adapt this rapidly"

End of the Last Ice Age



after Broeker, The Glacial World According to Wally, 2002; after Taylor et al; Greenland Ice Core Data (GISP)

End of the Last Ice Age



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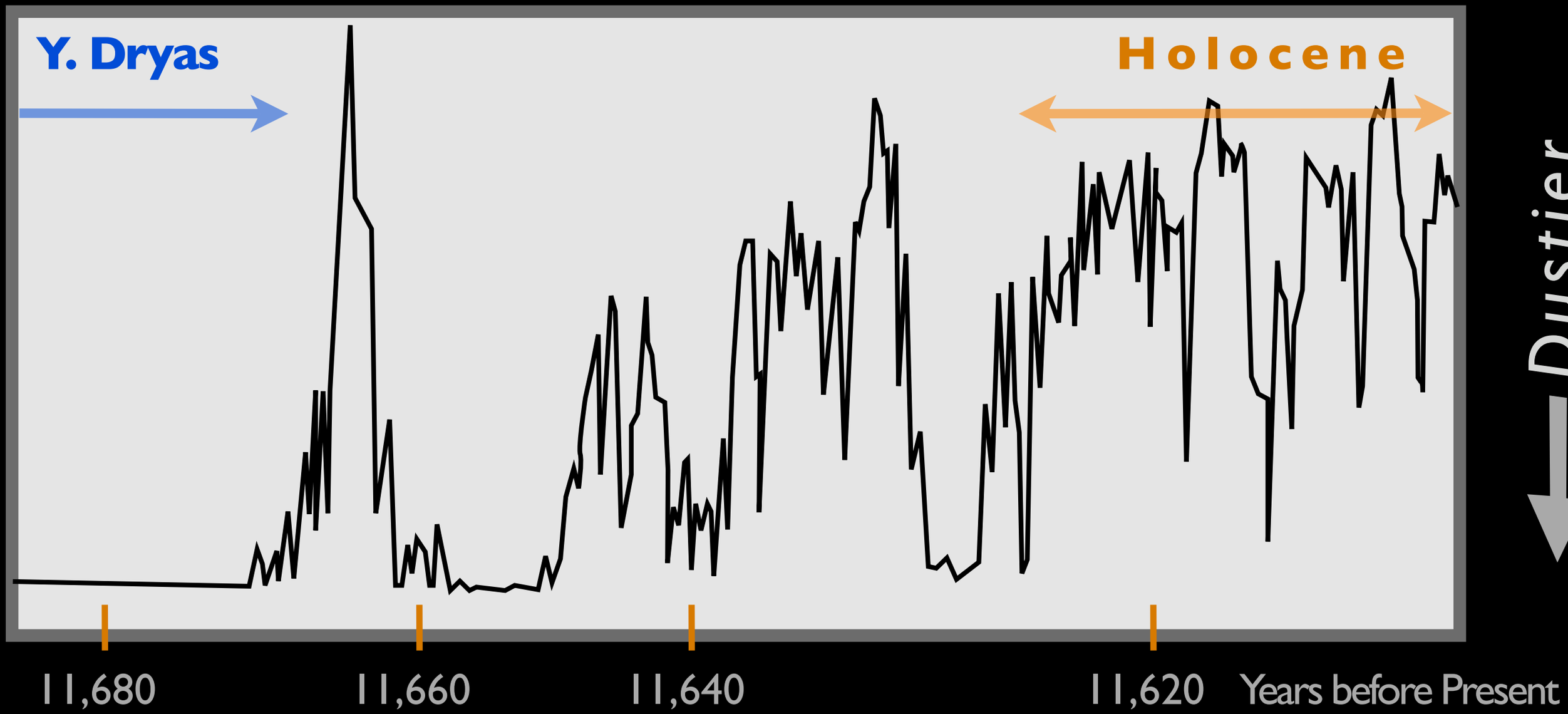

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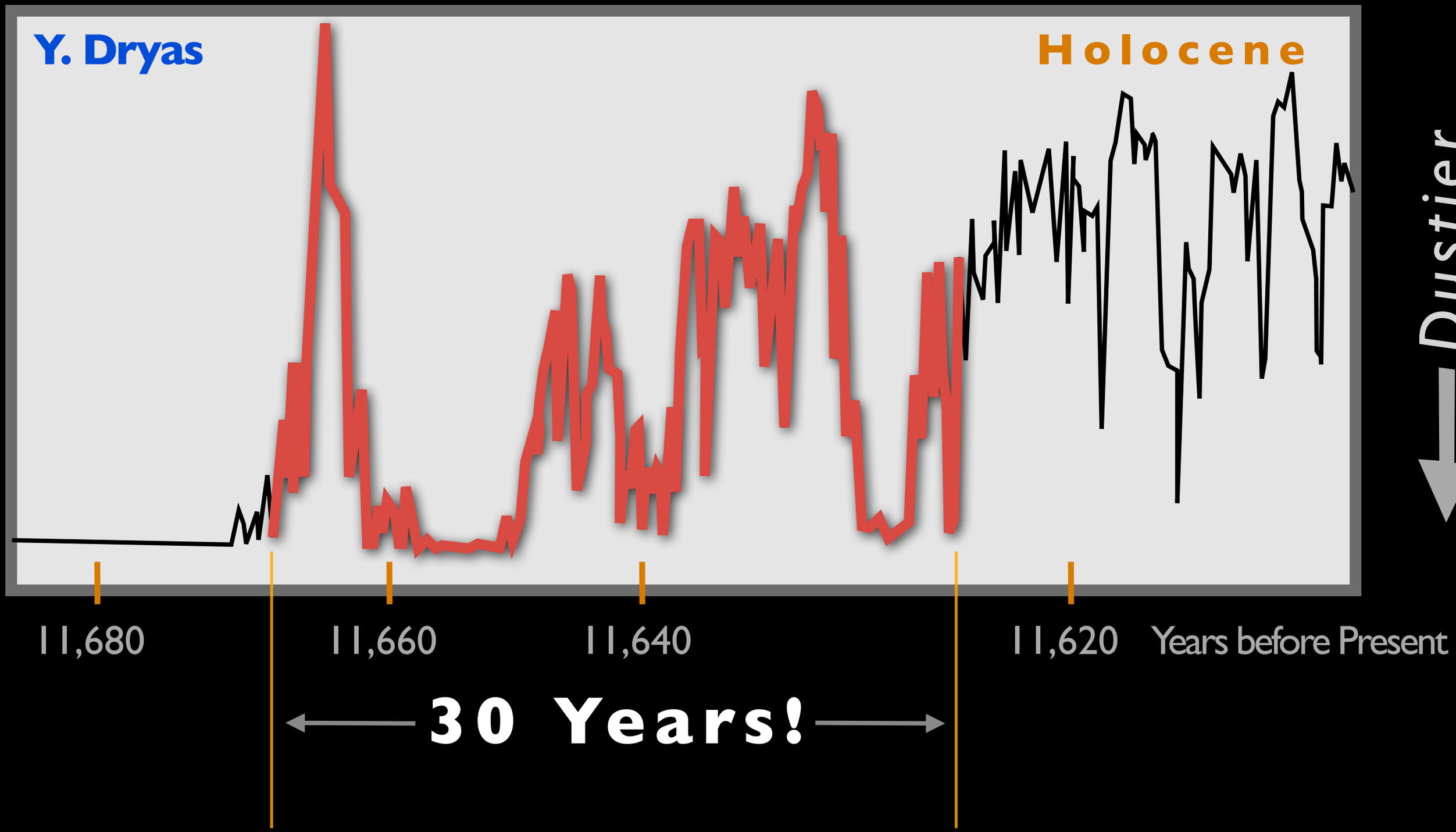

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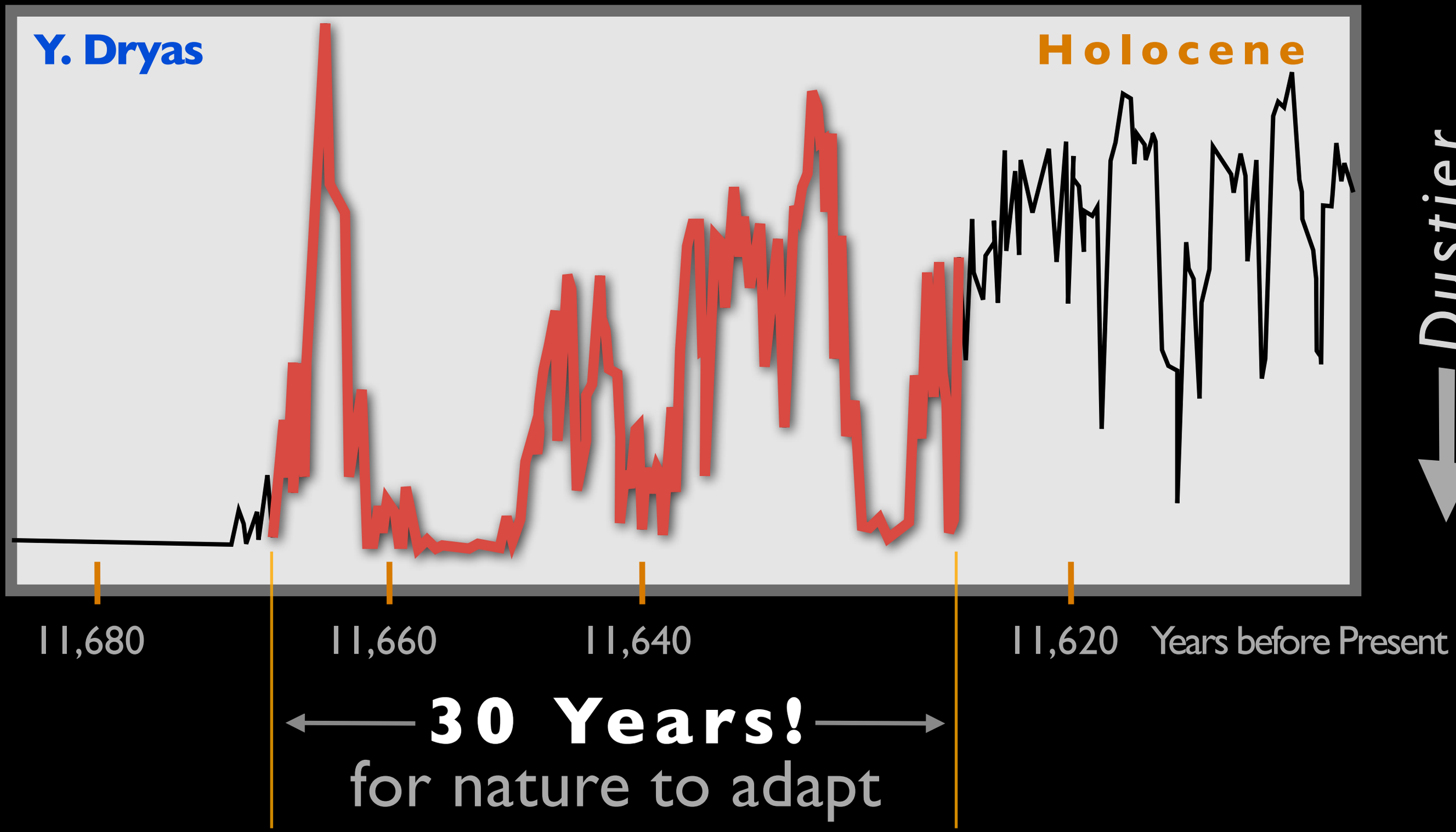

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hope

hope

+

work

but…what to do?

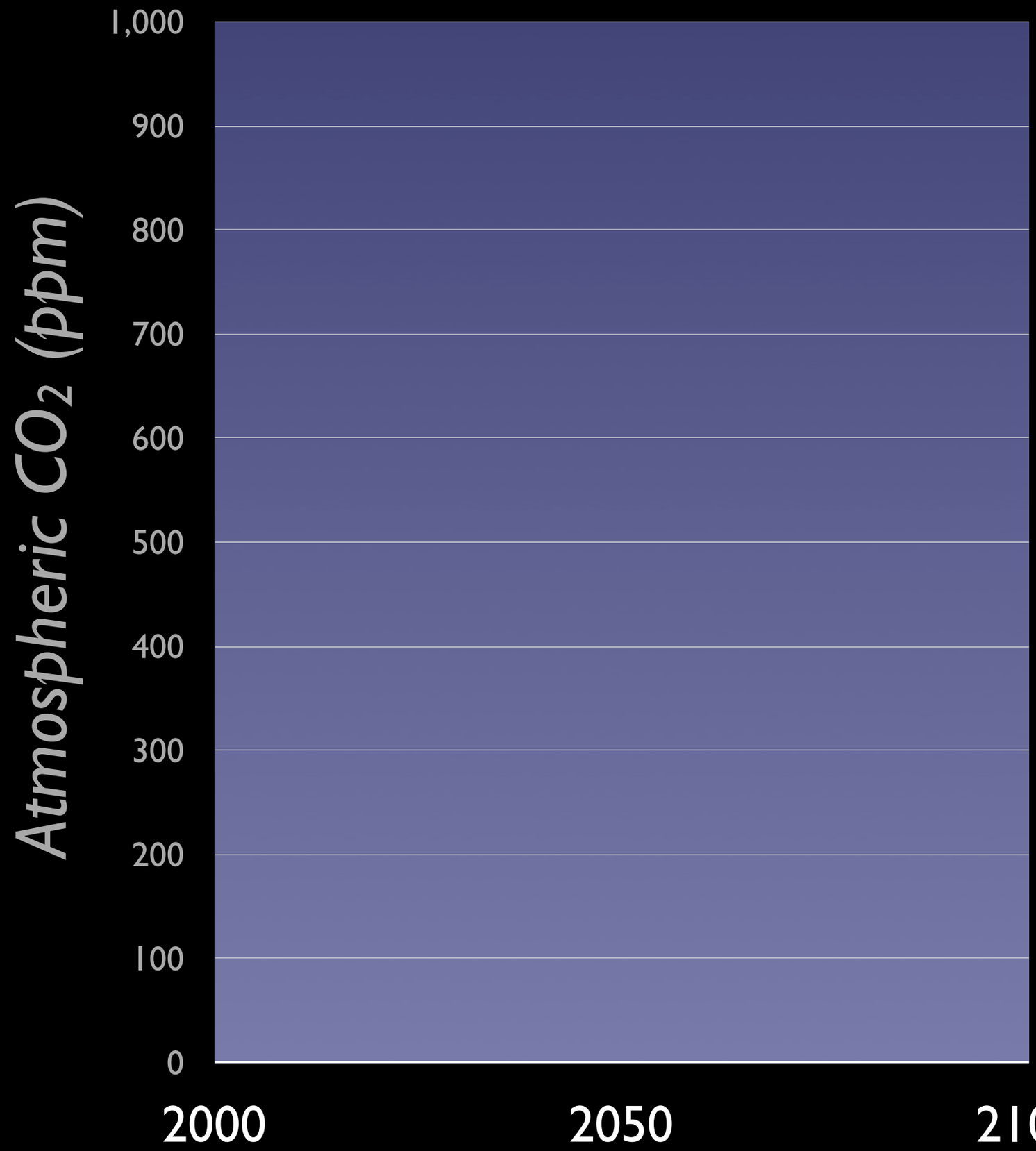
1. Adaptation
2. Engaging others
3. Managing carbon

Categories	Examples
Adaptation	1. Strategic land protection 2. Land stewardship/management
Engaging others	3. Community engagement 4. Outreach + education 5. Advocacy + policy
Managing carbon *(mitigation)*	6. Reduce organizational carbon footprint 7. Reforestation & Afforestation 8. Carbon trading

2.
Adaptation

general principles and examples

3 Scenarios for Future Emissions

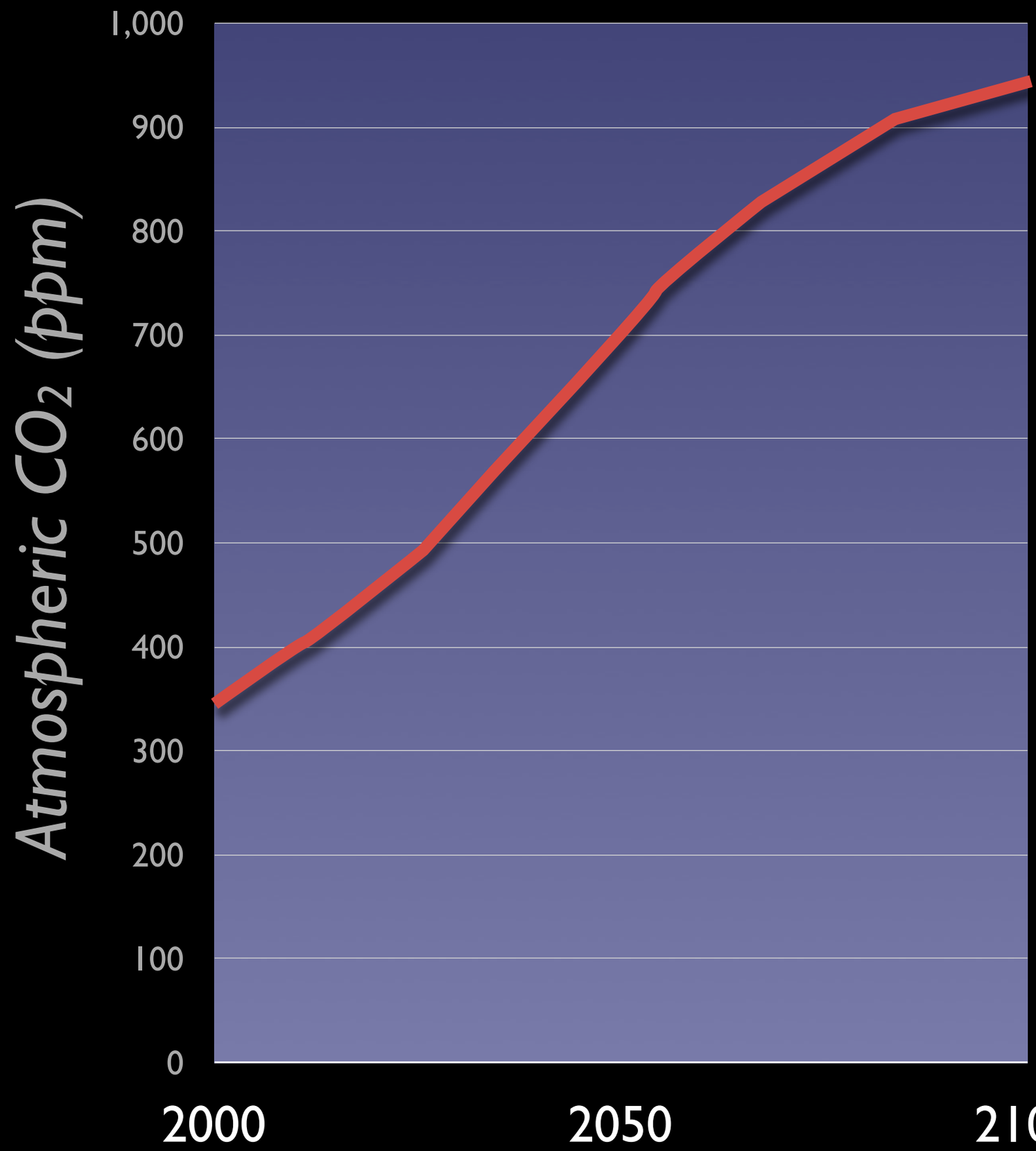


Business as Usual *(UCS High)*

Stabilization at Higher Level *(UCS Low)*

Stabilization + Restoration *(Hansen: Coal Phaseout with CCS)*

3 Scenarios for Future Emissions



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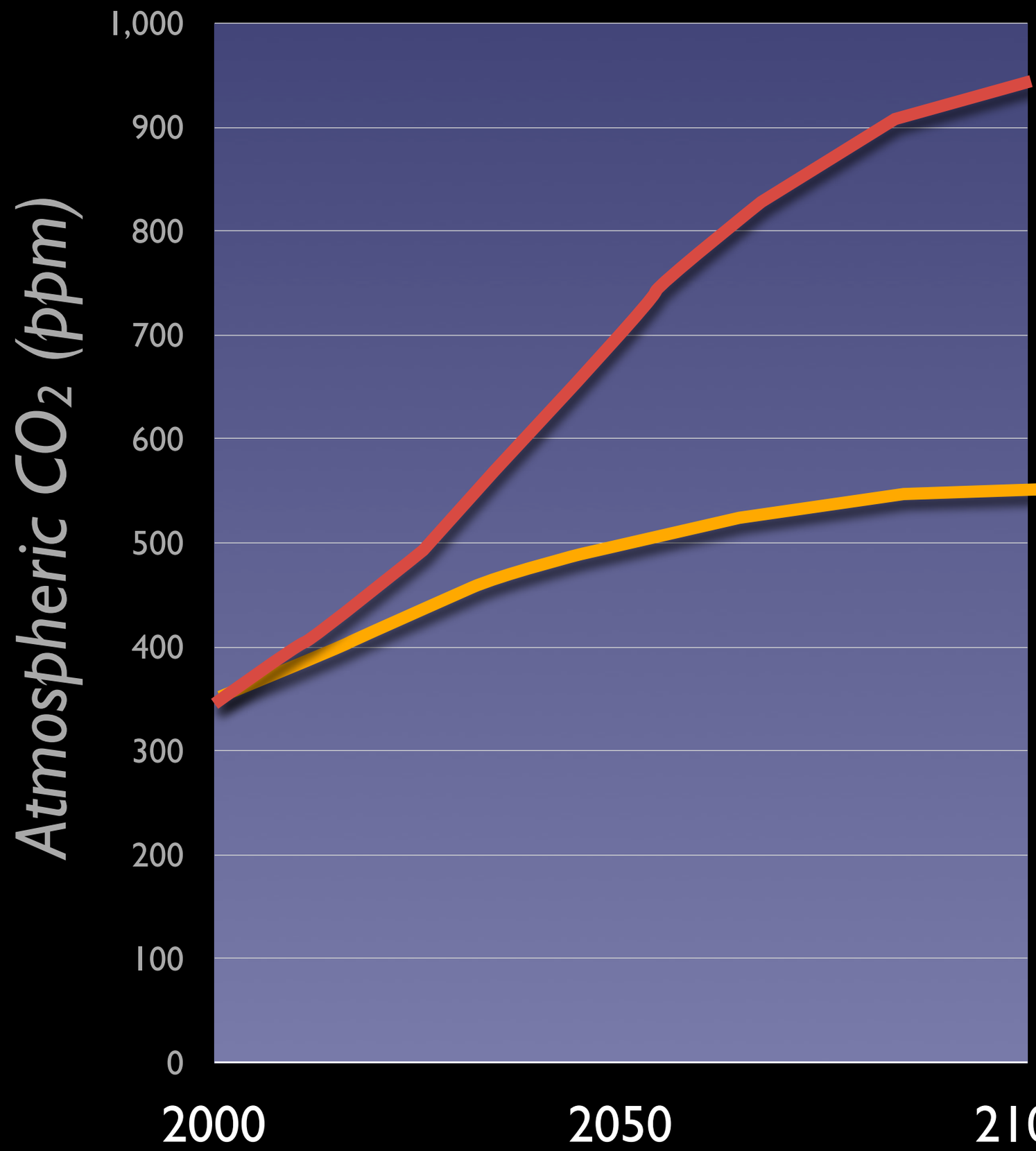

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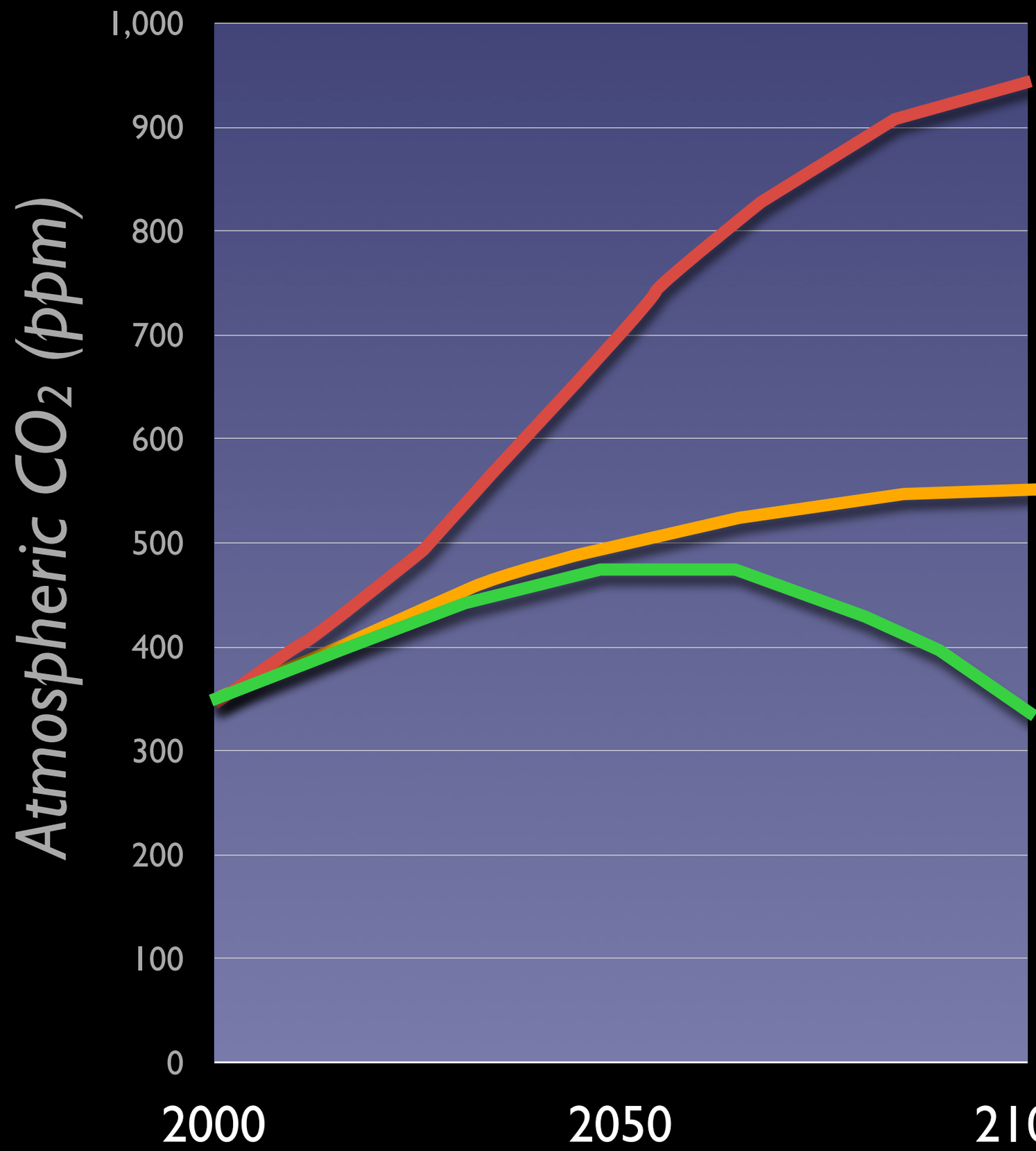

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Adaptation

Adaptation

"Initiatives + measures designed to reduce the vulnerability of natural and human systems against actual or expected climate change effects"

Glick et al, National Wildlife Federation, 2009

5 Strategies

1.

Reduce other non-climate stressors

Glick et al, National Wildlife Federation, 2009

5 Strategies

2.

Manage for ecological function + protection of biodiversity

Glick et al, National Wildlife Federation, 2009

5 Strategies

3.

Establish habitat buffer zones + wildlife corridors

5 Strategies

4.

Implement *proactive* management + restoration approaches

Glick et al, National Wildlife Federation, 2009

5 Strategies

5.

Increase monitoring + facilitate management under conditions of uncertainty

Glick et al, National Wildlife Federation, 2009

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Increase monitoring + facilitate management under conditions of uncertainty

Glick et al, National Wildlife Federation, 2009

4 Key Principles

(frequently used climate adaptation terminology)

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resilience + resistance

4 Key Principles

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resilience + resistance

representation

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refugia + corridors

4 Key Principles

(frequently used climate adaptation terminology)

resilience + resistance

representation

refugia + corridors

adaptive learning

Strategies

Principles	Reduce non-climate stressors	Manage for ecological function + protect biodiversity	Establish habitat buffer zones + corridors	Implement *proactive* management + restoration approaches	Increase monitoring + facilitate management under conditions of uncertainty
Resilience + Resistance	X	X	X	X	
Representation		X	X	X	
Refugia + Corridors		X	X		
Adaptive learning				X	X

Resilience + Resistance

"Ability of a system to withstand or bounce back from disturbance"

Build Resilience!

Build Resilience!

1. **Represent** & protect environmental settings

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2. Protect ecosystems of sufficient **size**

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2. Protect ecosystems of sufficient **size**
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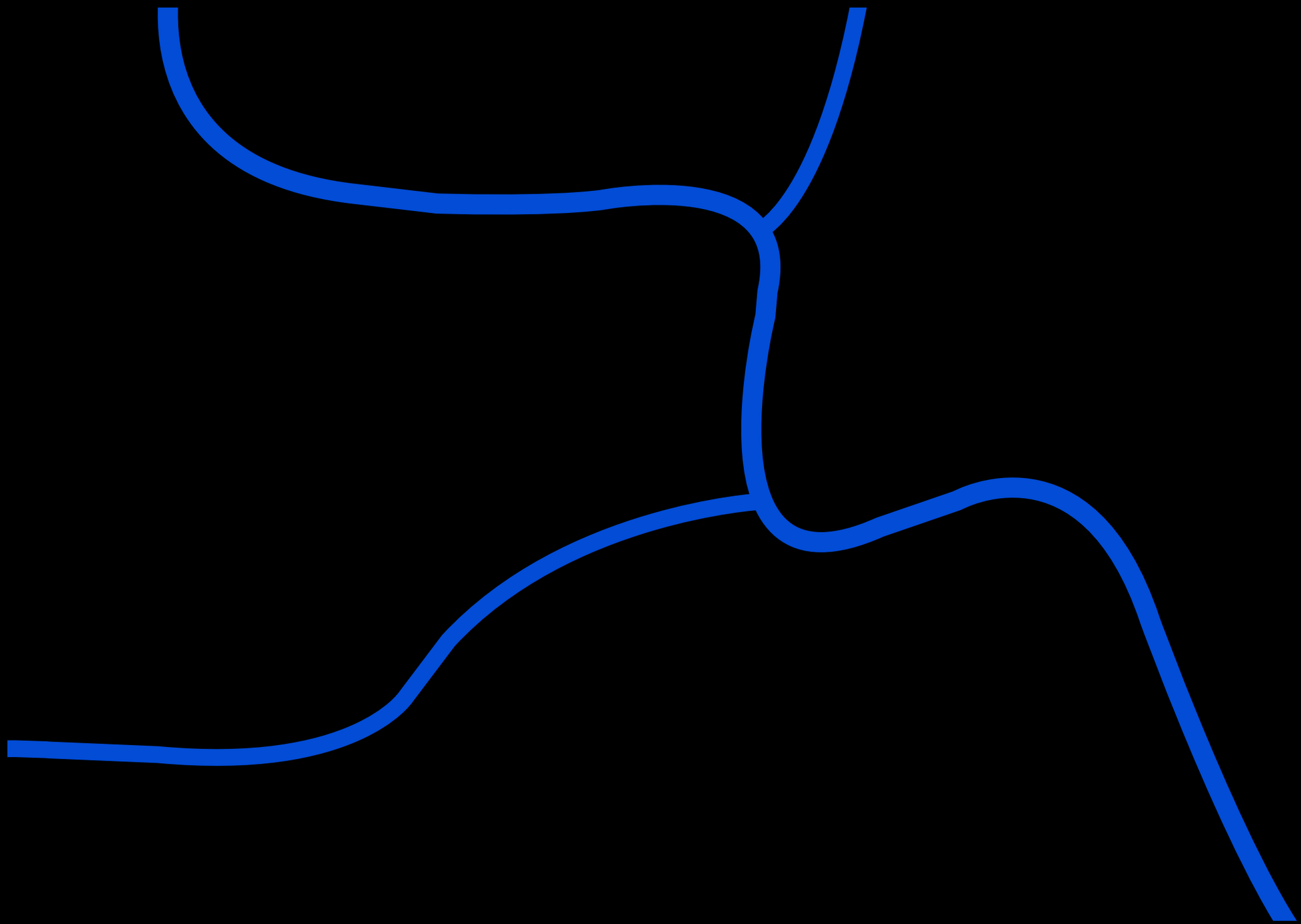
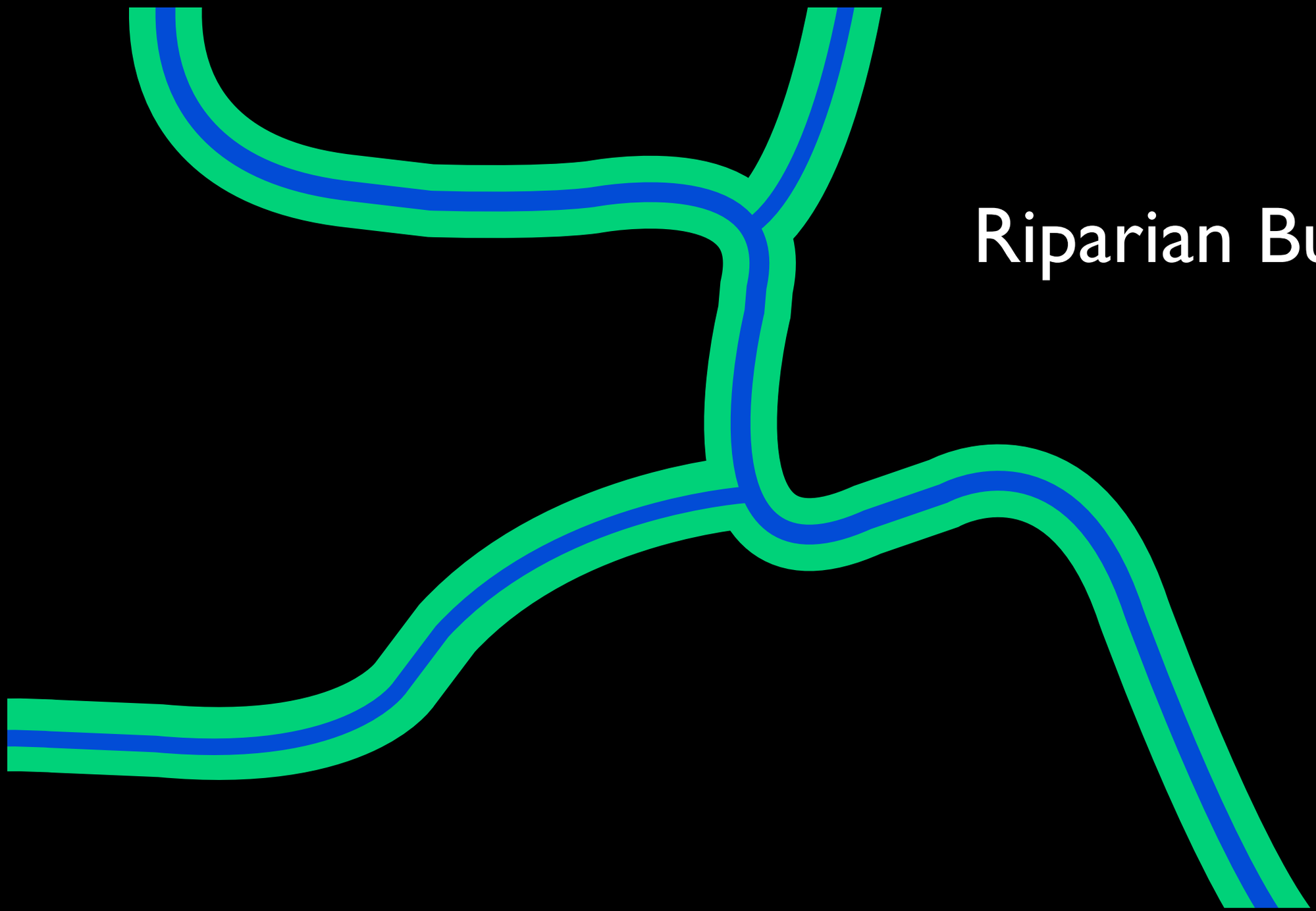
5. **Limit** non-climate **stresses**
6. Maintain species **richness**

Resilience + Resistance

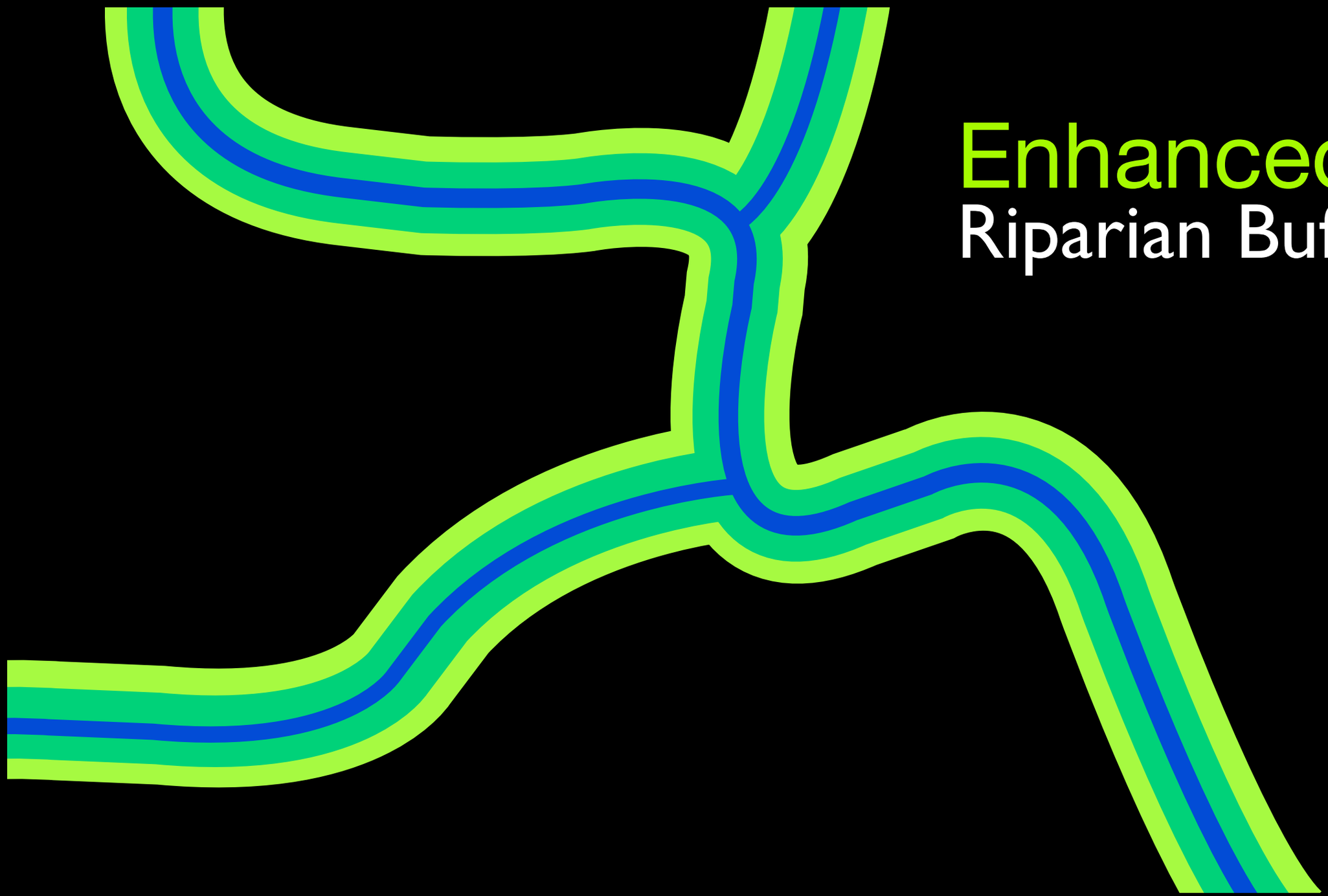


Resilience + Resistance



Riparian Buffers

Resilience + Resistance



Enhanced
Riparian Buffers

Resilience + Resistance

Identifying and Protecting Wetlands

Resilience + Resistance

Satellite Image Analysis to Verify Areas of Active Flooding

April 14, 2001

Sept. 5, 2001

Resilience + Resistance

Satellite Image Analysis to Verify Areas of Active Flooding

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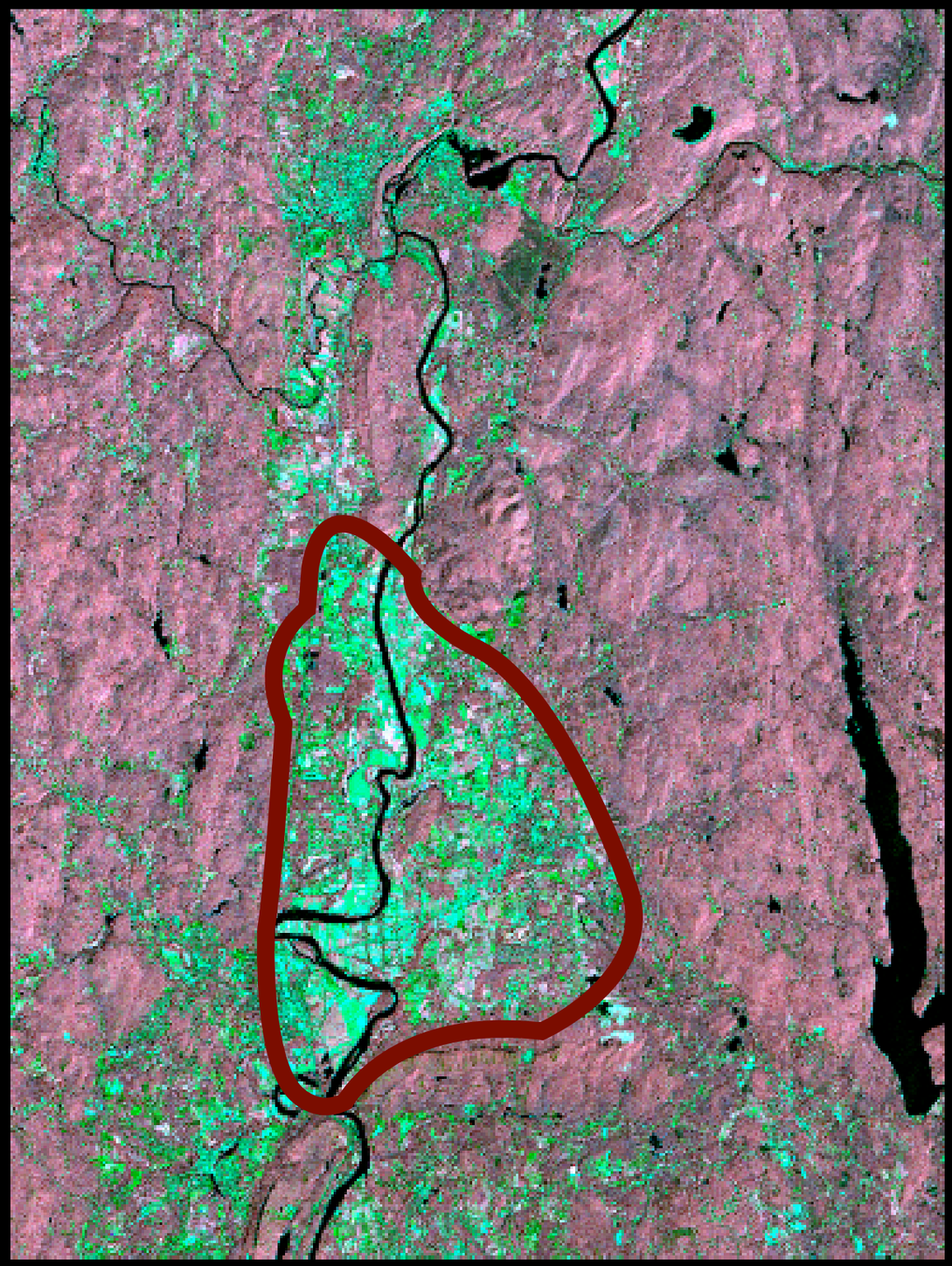


Sept. 5, 2001

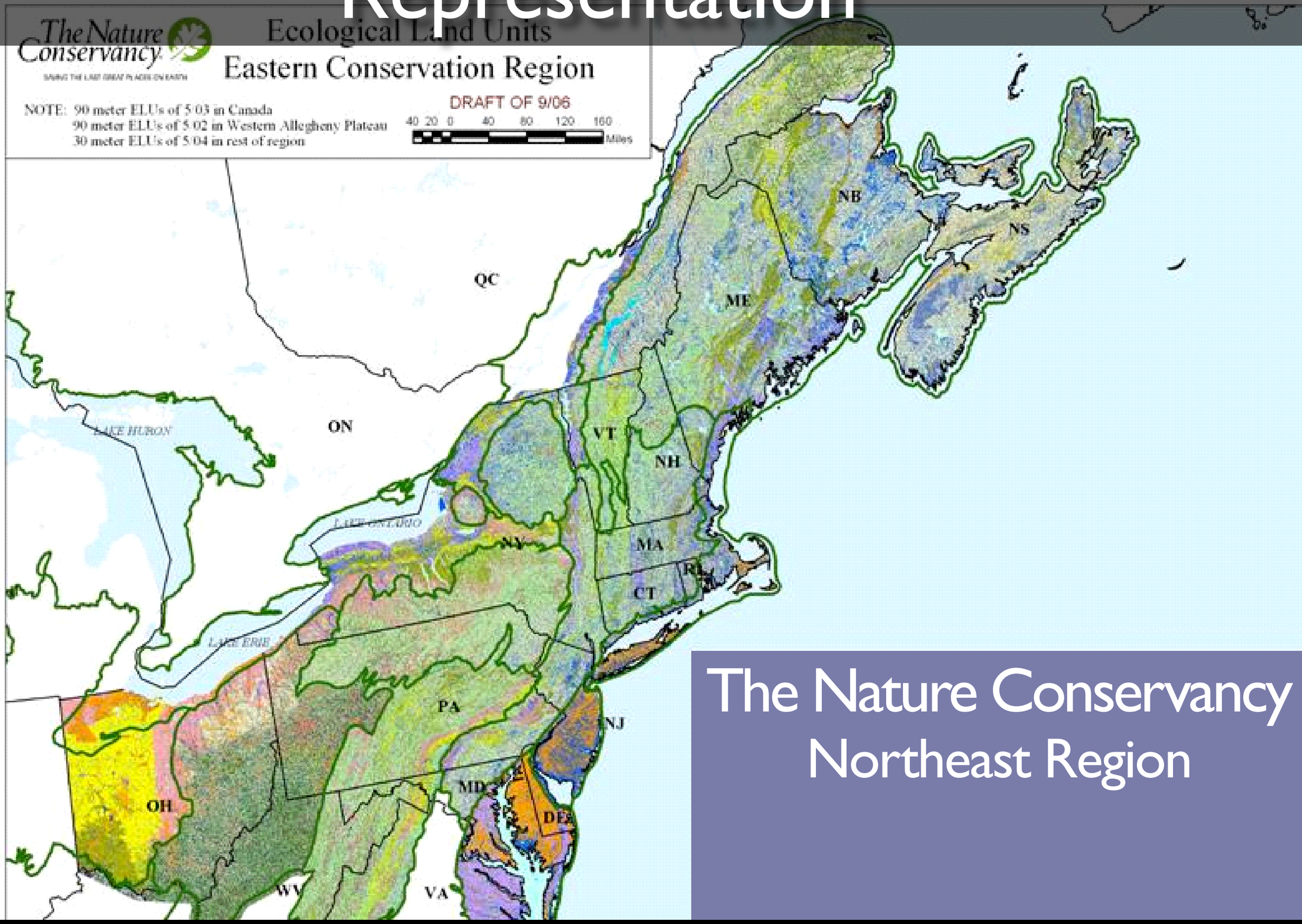
Resilience + Resistance

Accelerate efforts to restore natural areas

Dam removal

Invasives control

Representation

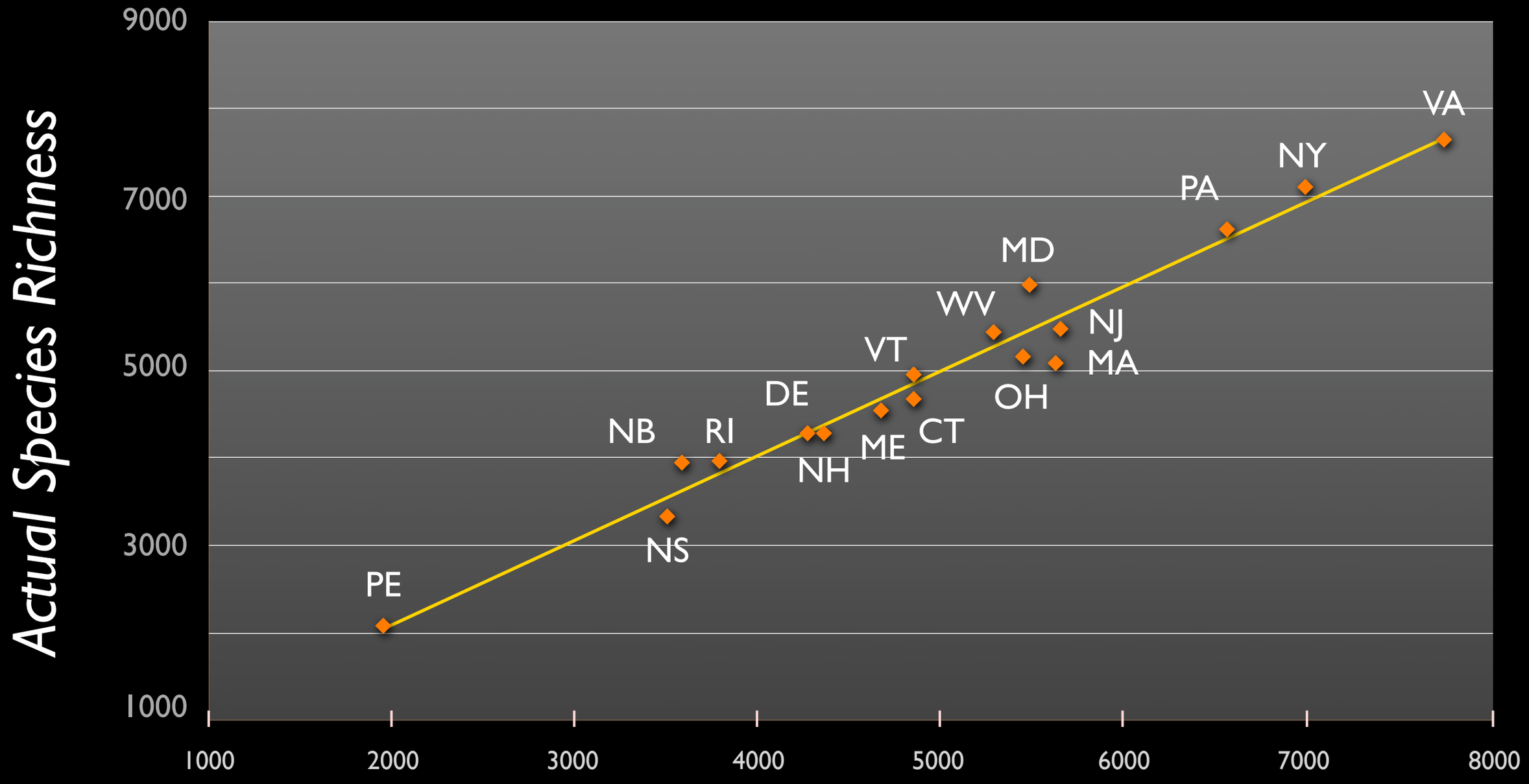


The Nature Conservancy
Northeast Region

Anderson, 2008 in prep.

Species Richness

No. of Bedrock Types, No. of Elevation Zones, Maximum Hardiness Zone, Longitude (increasing), Amount of Calcareous Substrate



Predicted Species Richness

Based on the best-fit, a stepwise regression of 42 variables

Anderson, 2008 in prep.

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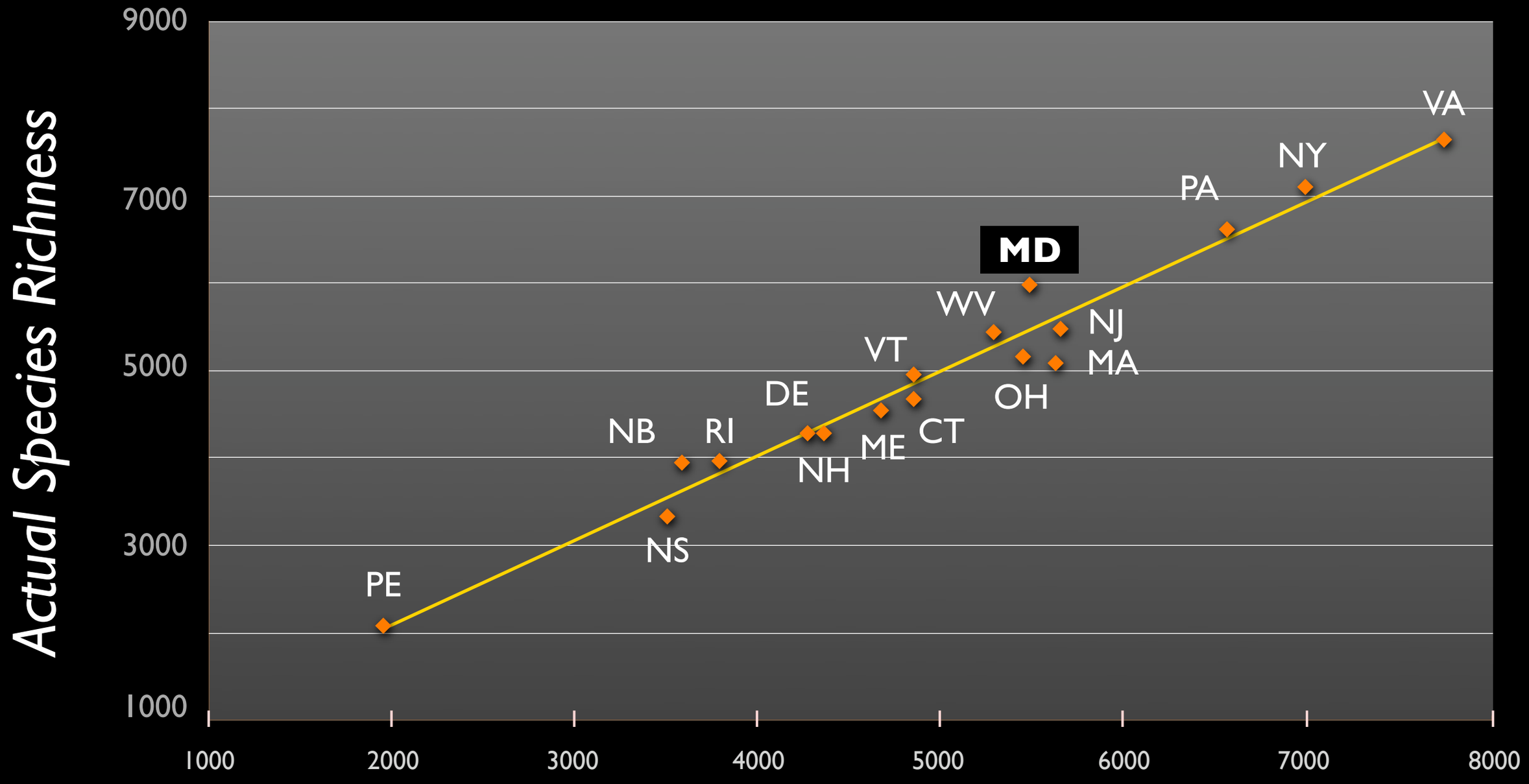

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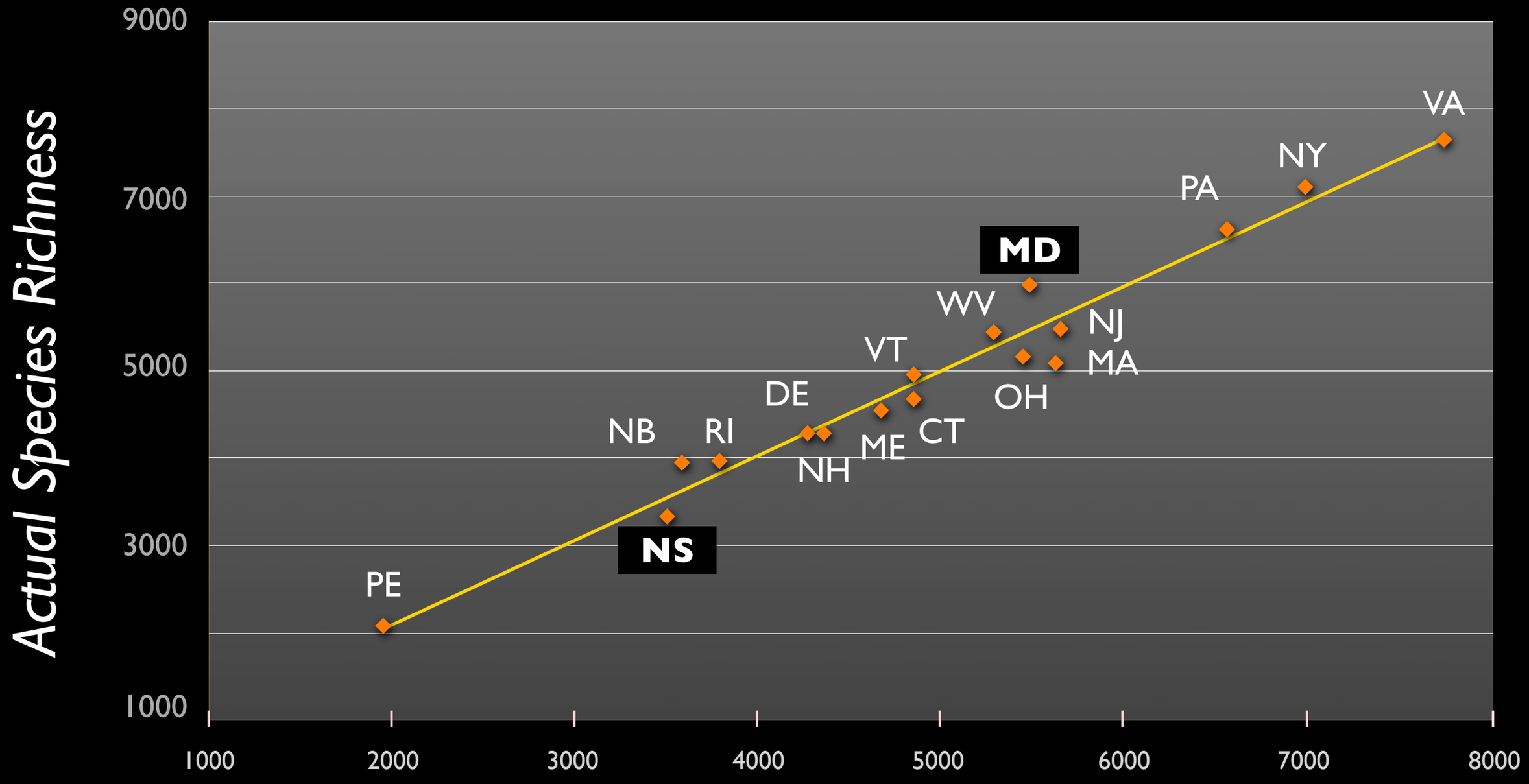

Predicted Species Richness

Based on the best-fit, a stepwise regression of 42 variables

Anderson, 2008 in prep.

Protect arenas for evolution, NOT museums of the past.

Focus on the stage and the play, not the individual actors.

Forests

Summits

Coves

Steep Slopes/Cliffs

Rivers & Streams

Freshwater wetlands

Riparian

Tidal Marsh & Beach

Photos Courtesy Dr. Mark Anderson, TNC

"While at any one place the species composition will change, the geophysical features endure and their significance to biodiversity will remain."

Dr. Mark Anderson, The Nature Conservancy

A Shift in Paradigms

	OLD	NEW
Target **1**	Cattail (Typha latifolia) – Marsh Marigold (Caltha palustris) herbaceous vegetation	Freshwater marsh ecosystem on shale at low elevation.
Target **2**	Cattail (Typha angustifolia, latifolia) – Bullrush (Shoenoplectus spp.) herbaceous vegetation	Freshwater marsh ecosystem on granite at high elevation

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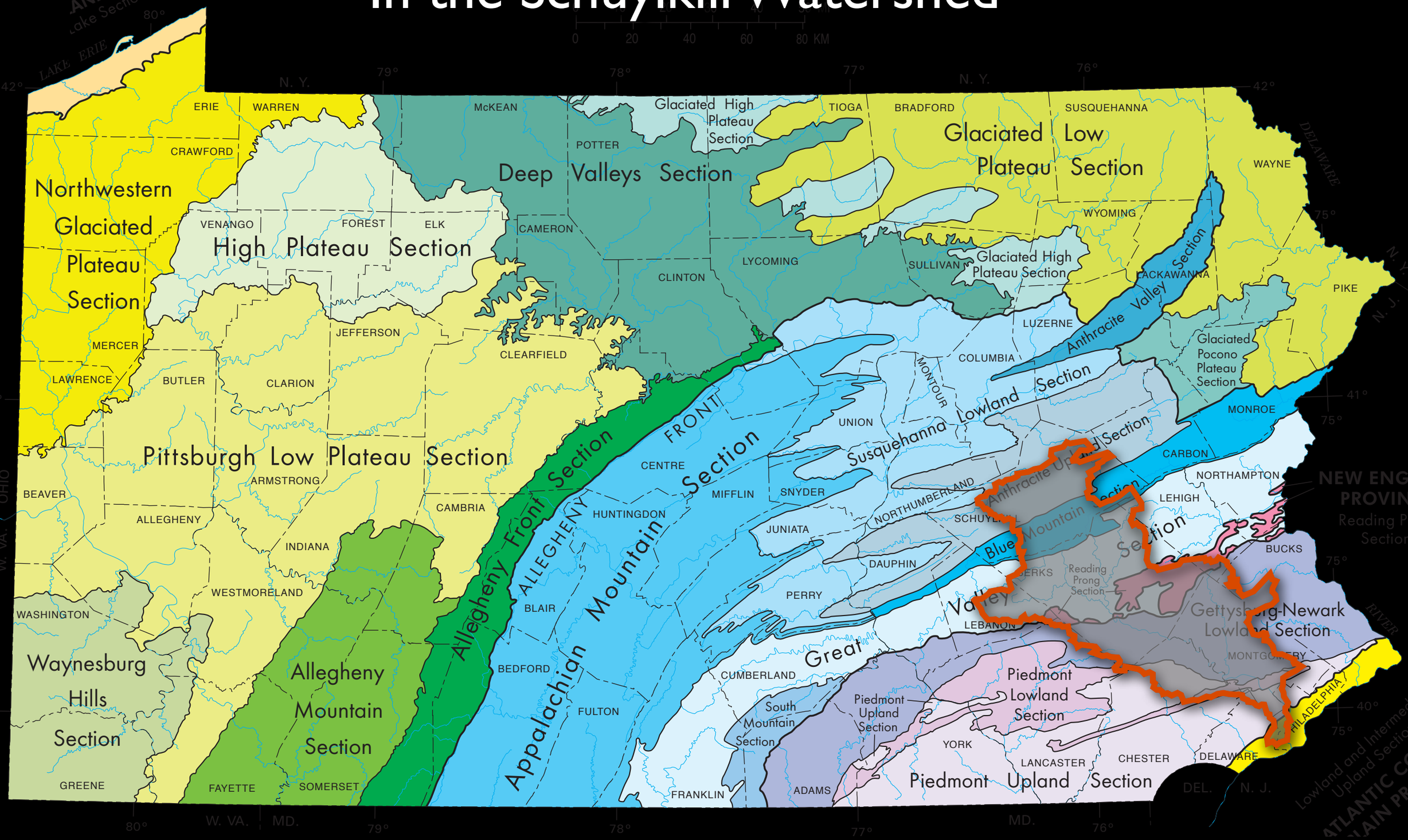
Representation

1. Represent vital settings + physical gradients
2. Protect ecosystems of sufficient size and quality
3. Distribute risk across geographically-dispersed replicates
4. Maintain natural processes + prevent isolation of targets
5. Implement strategies that protect the whole portfolio

Representation

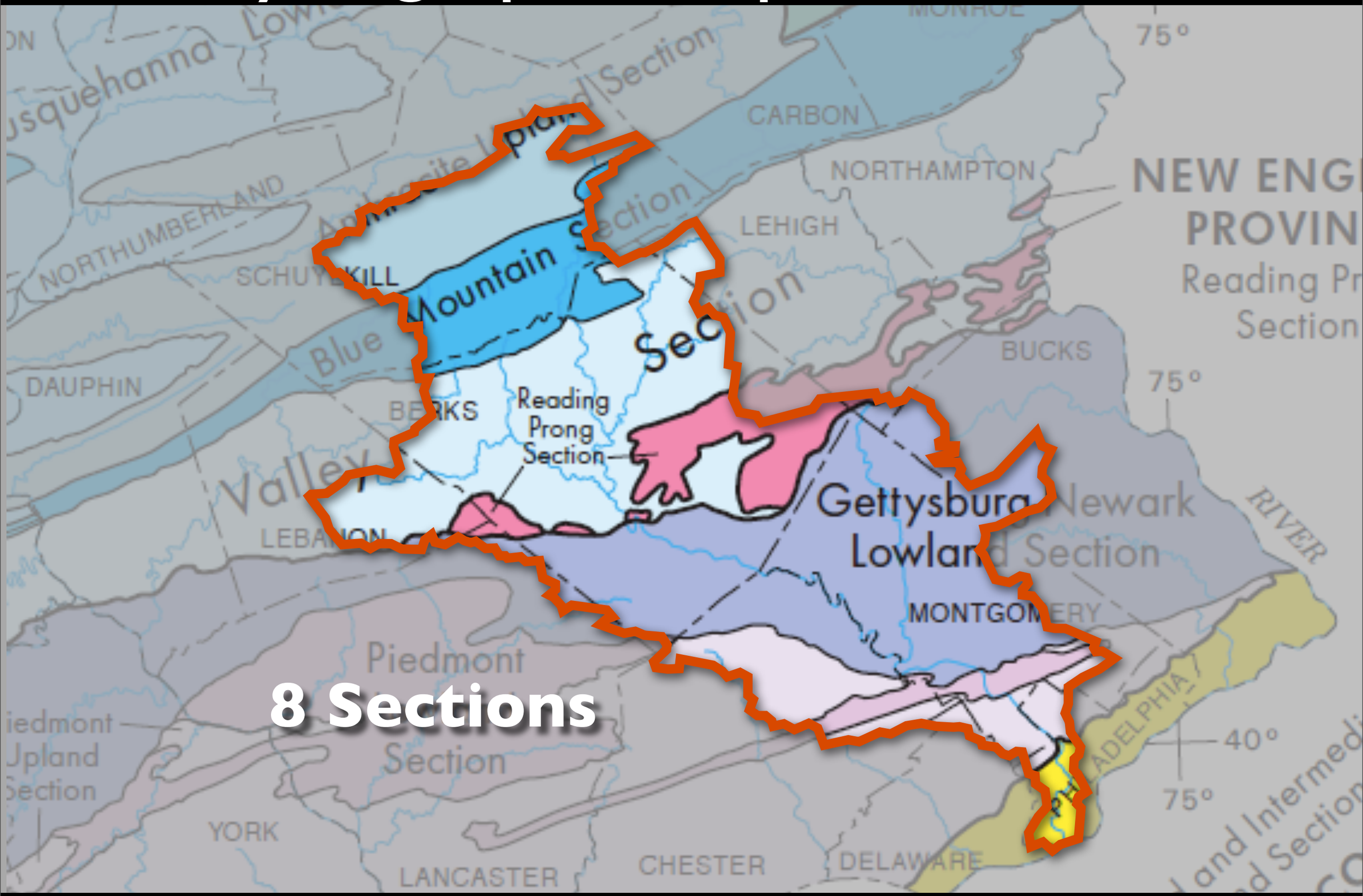
In the Schuylkill Watershed



Physiographic Provinces of Pennsylvania

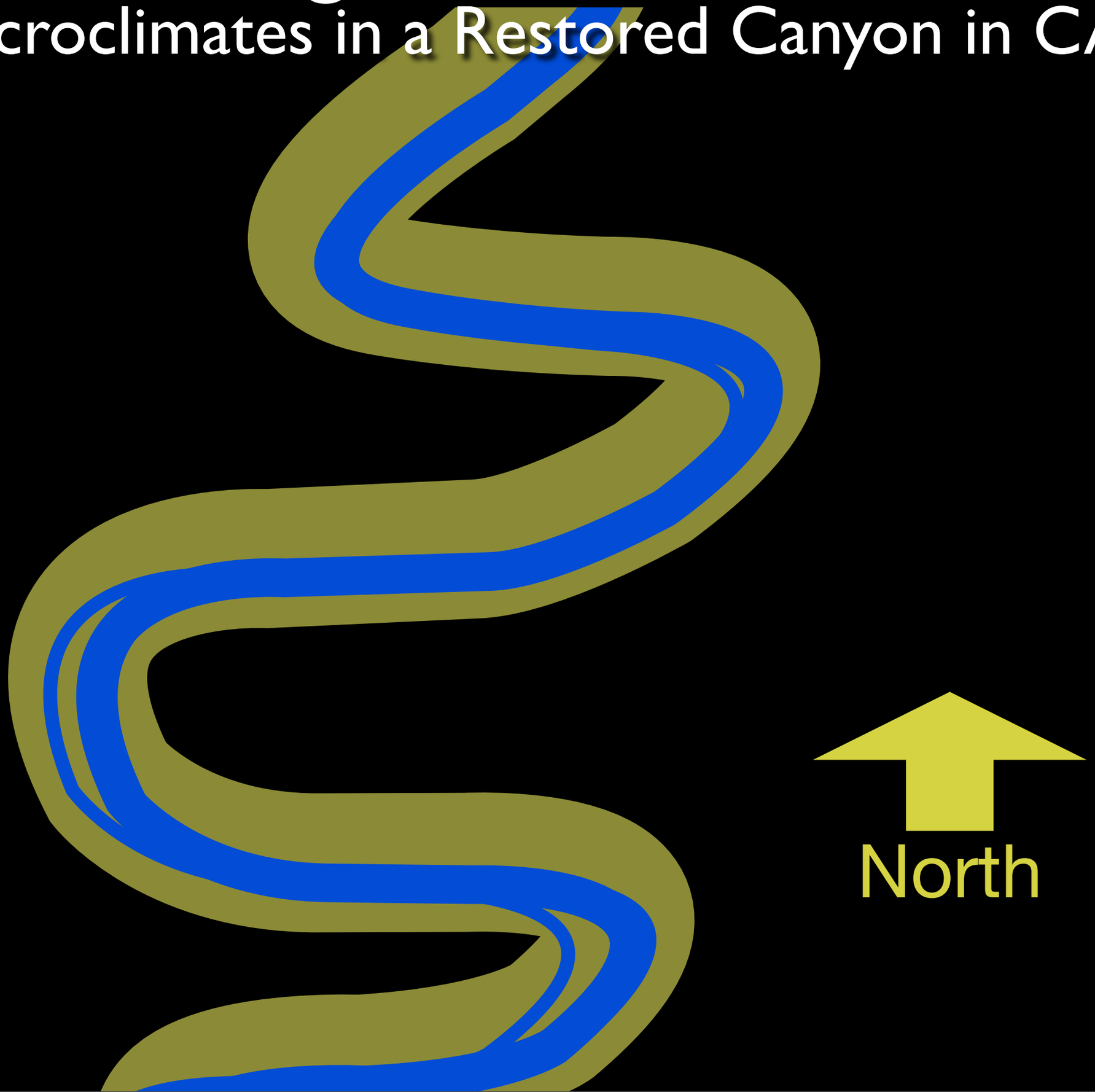
Pennsylvania DCNR

Physiographic Representation



Refugia + Corridors

Microclimates in a Restored Canyon in CA



North

Refugia + Corridors

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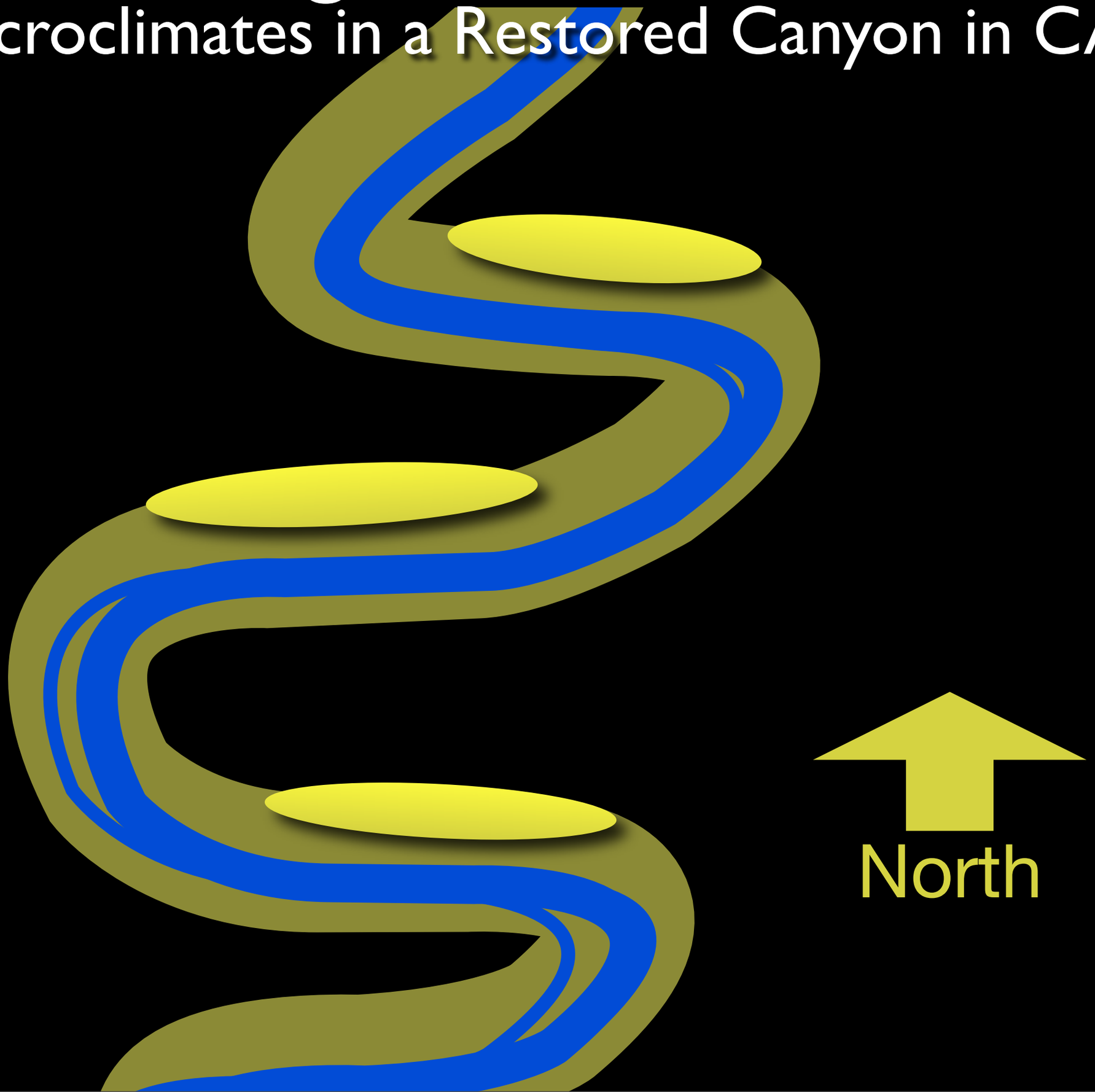

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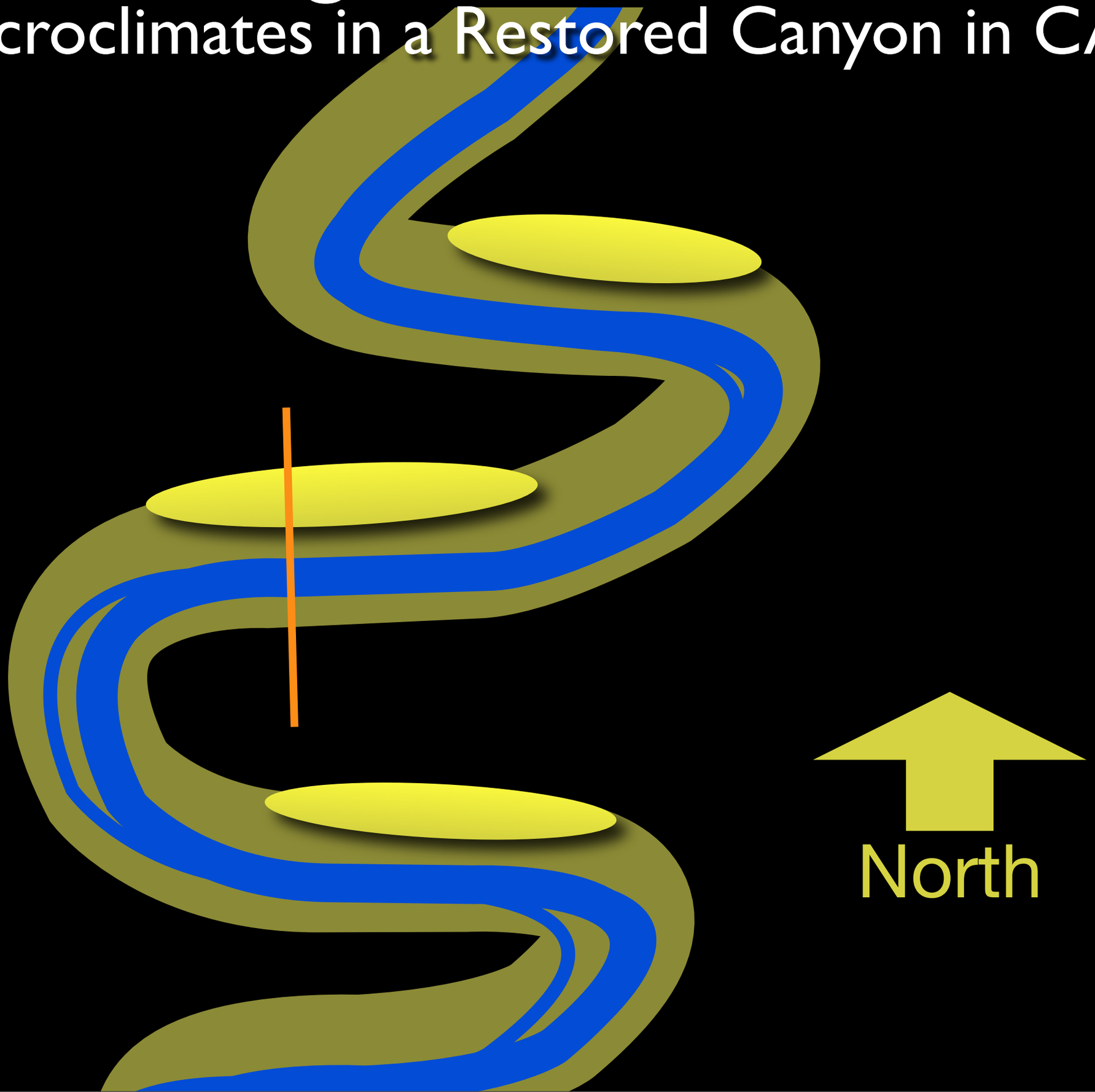


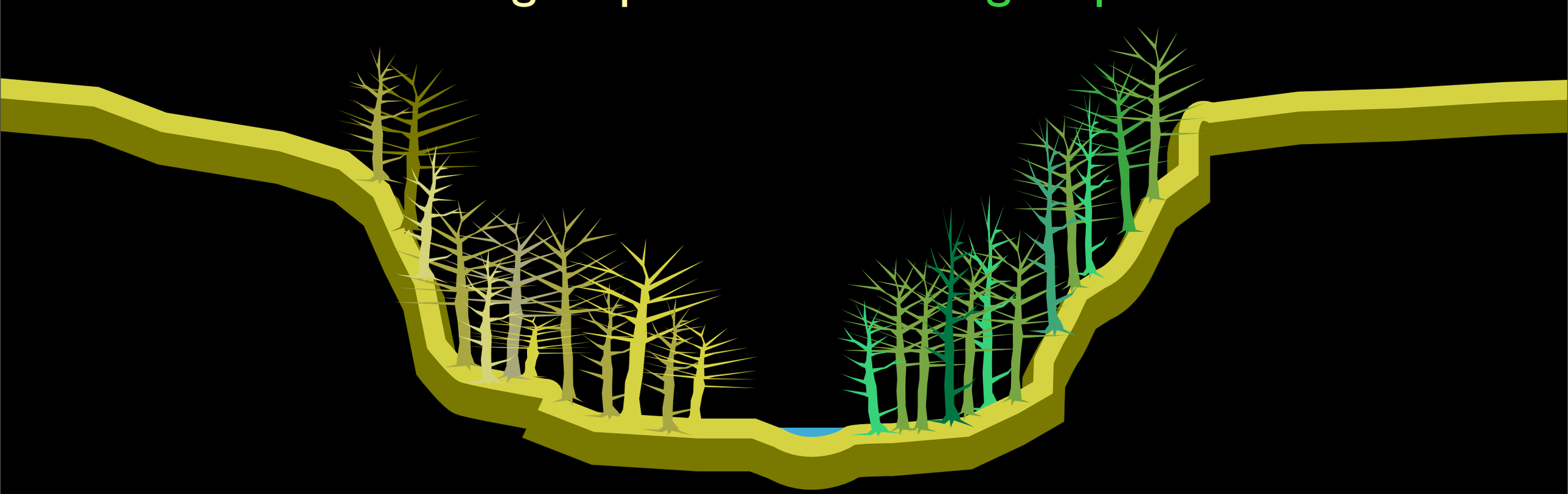
Refugia + Corridors

Microclimates in a Restored Canyon in CA

North

Warm South Facing Slopes

Cool North Facing Slopes



Cross Section

Refugia + Corridors

Coastal Cutthroat Trout

(Oncorhychus clarkii clarkii)

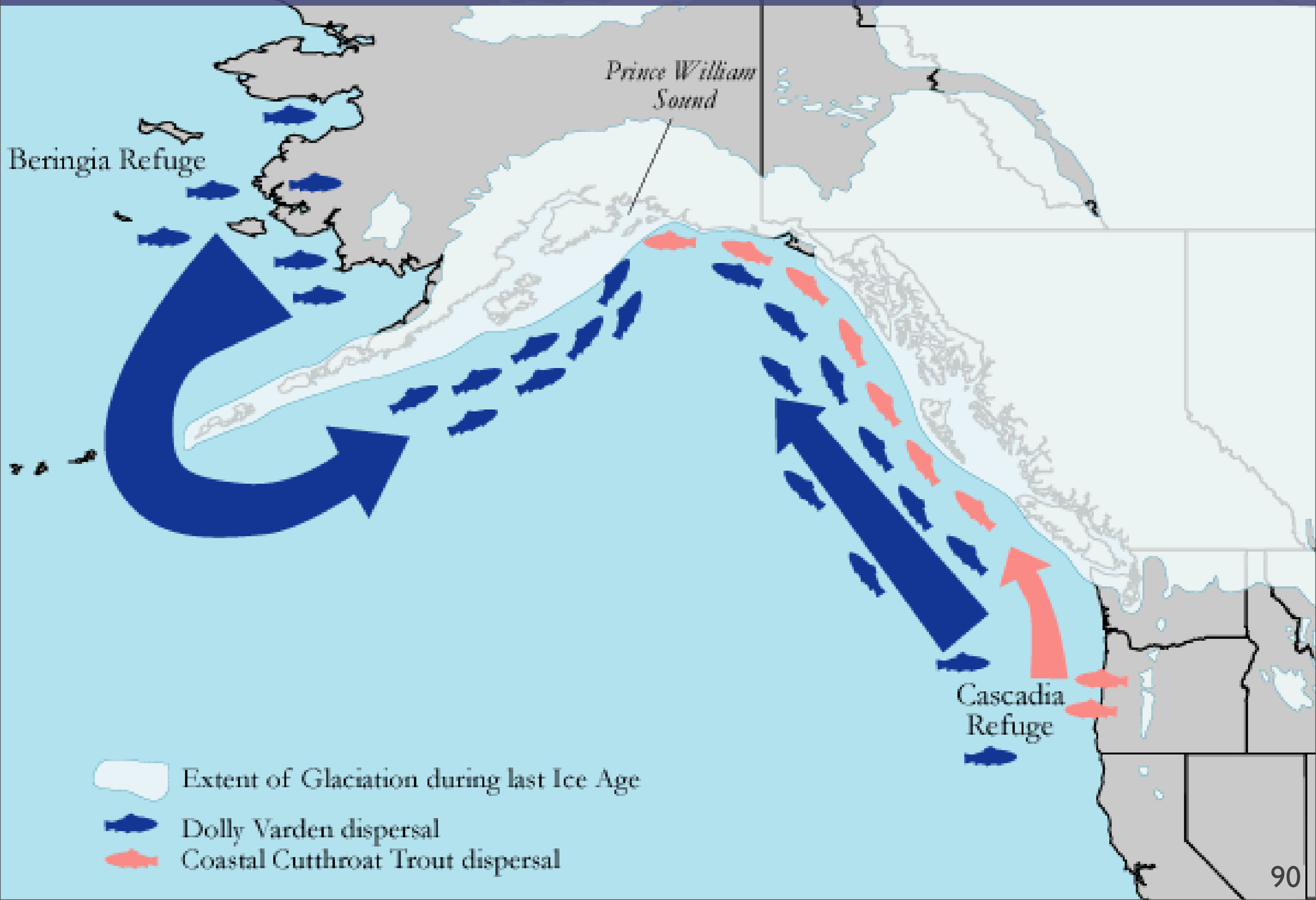
Refugia + Corridors

Dolly Varden (Char)

(Salvelinus malma Walbaum)

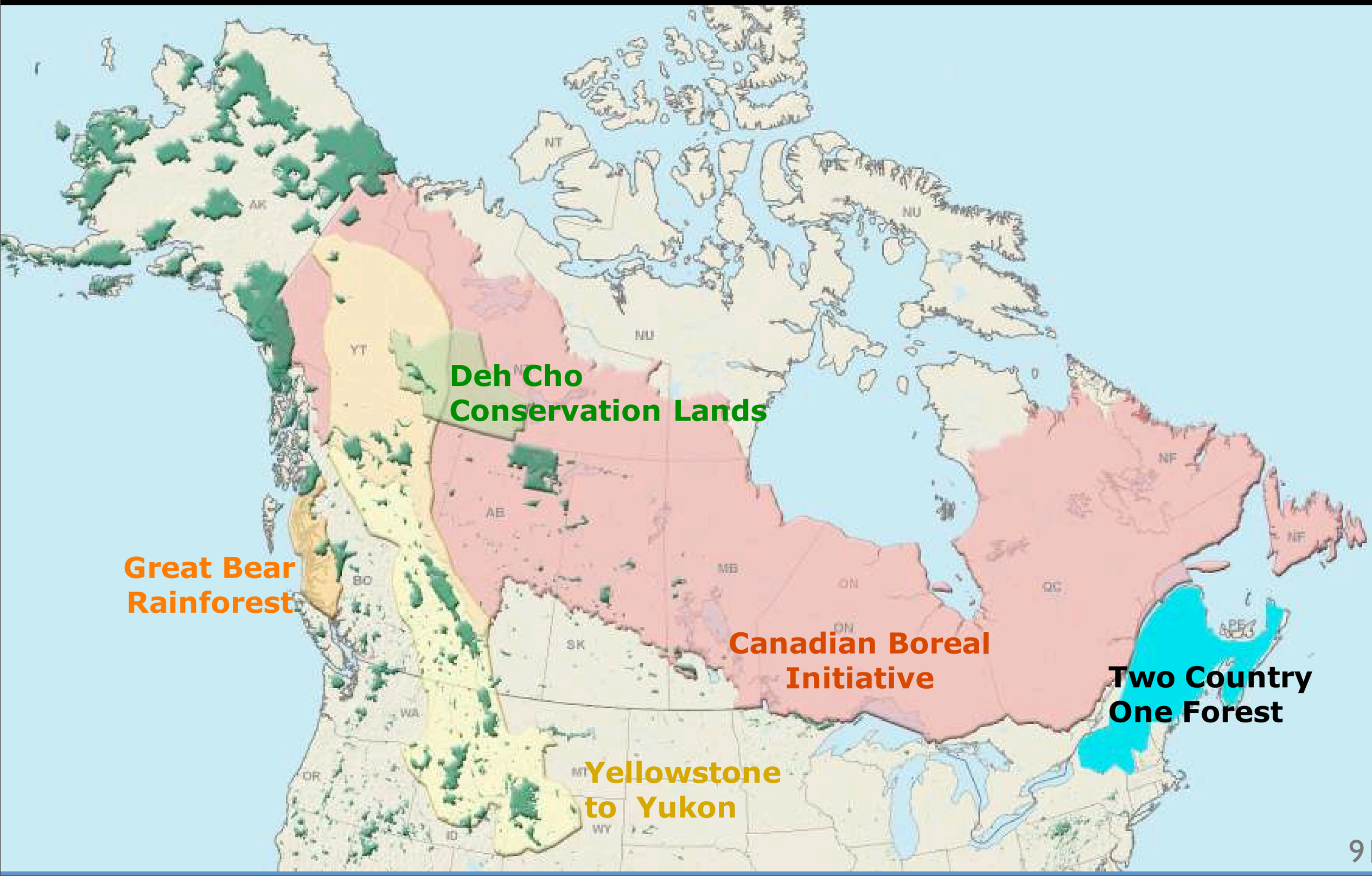
John Bavaro

Refugia + Corridors



Refugia + Corridors

Continental Connectivity Corridors



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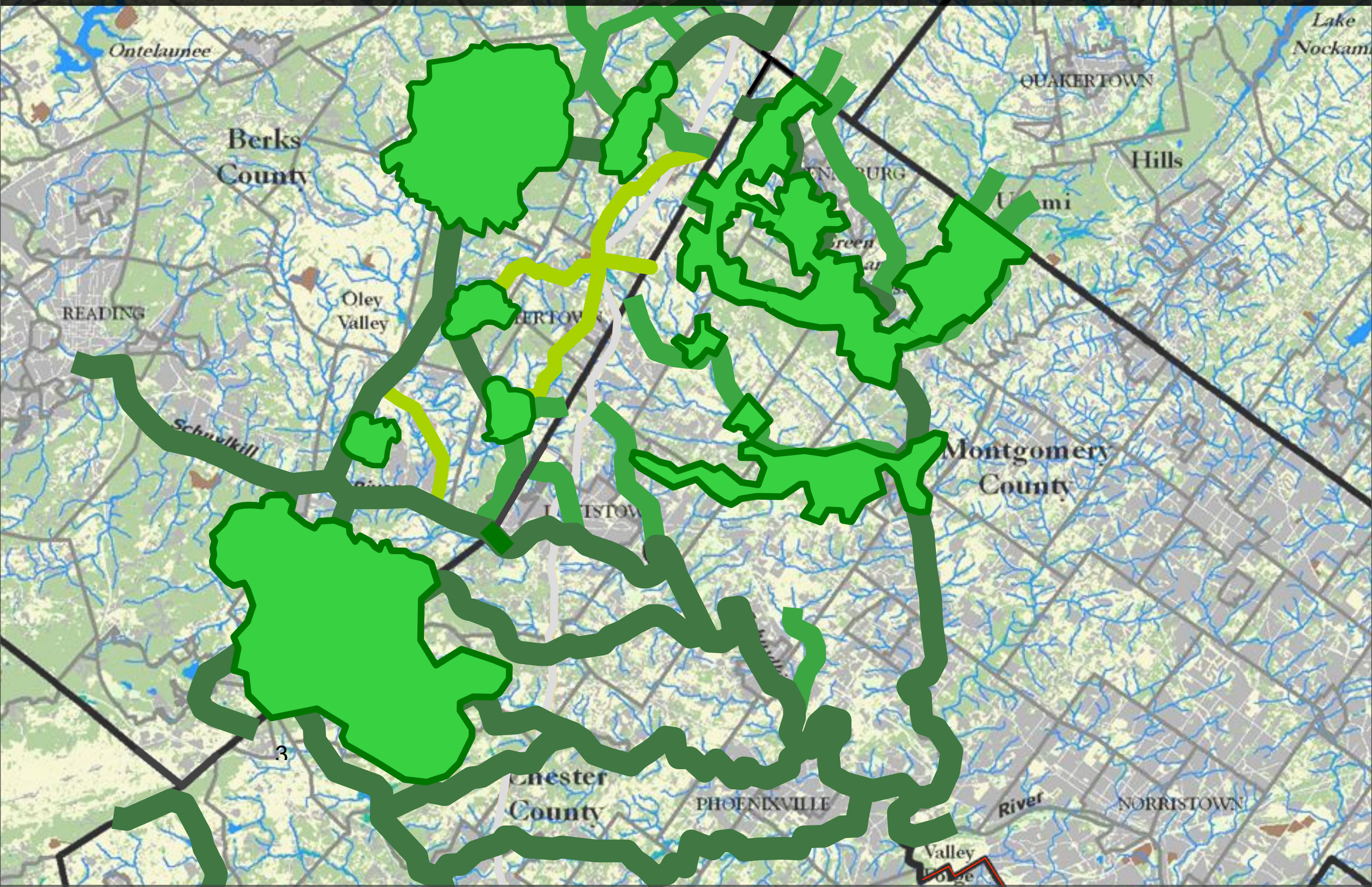


Sources: PASDA (Land Cover), Berks Co. *County Greenway Network;* Chester Co. *Landscapes*; Montgomery Co. *Composite Open Space System*

Refugia + Corridors

Anticipatory Land Protection Strategies

Kennebec Estuary Project

The Nature Conservancy

Seed Banking + Facilitated Migration

New England Wildflower Society

Responsive Management:

1. Seed banking
2. Invasive species control
3. Facilitate migration
4. Replanting invaded habitats

Seed Banking + Restoration

To keep every cog and wheel is the first precaution of intelligent tinkering.

Aldo Leopold

MILLENNIUM SEED BANK PROJECT Kew

www.kew.org/msbp/index.htm

How do we make decisions under conditions of uncertainty?

Adaptive Learning

Adaptive Learning

What's Missing?

Shared Learning!

3.
Engaging Others

outreach, education and policy

Community Engagement

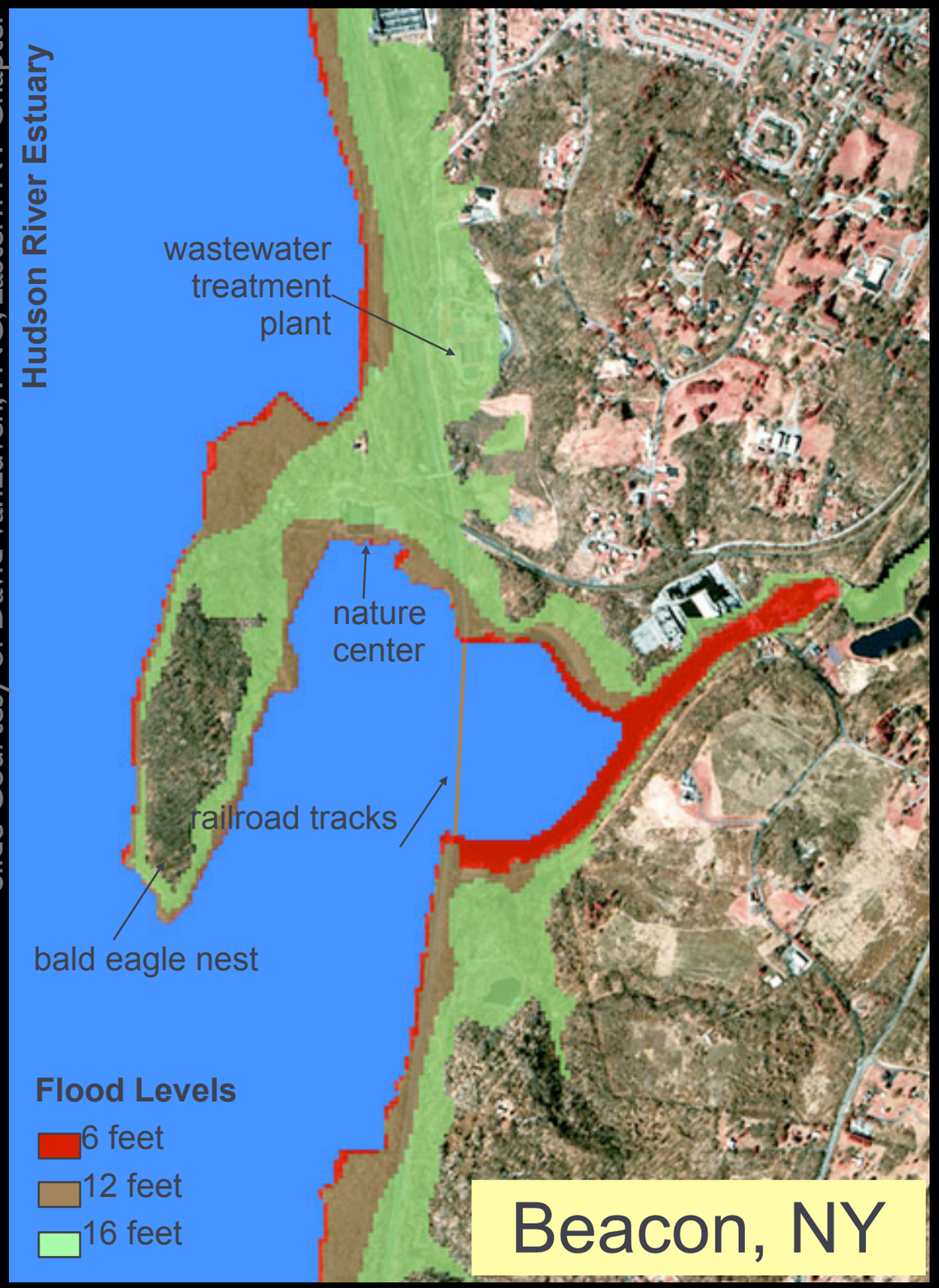
Rising Waters Project on Hudson River

Tim Howard, NY Natural Heritage Program

The Nature Conservancy

Community Engagement

Rising Waters Project on Hudson River



Slide Courtesy of David vanLuven, TNC, Eastern NY Chapter

We are all affected

- businesses + residents in floodplains
- emergency first responders
- roads, bridges, railroads
- natural systems

not just an "environmental" issue

The Nature Conservancy

Community Engagement

Benefits of Rising Waters Project

Slide Courtesy of David vanLuven, TNC, Eastern NY Chapter

- Diversifies concern about climate change
- Broad coalitions = more political clout
- Broad coalitions can access more government funds
- More political clout + more funds = implementation

The Nature Conservancy

Emerging Federal Adaptation Policy (based on HR 2454: ACES bill)

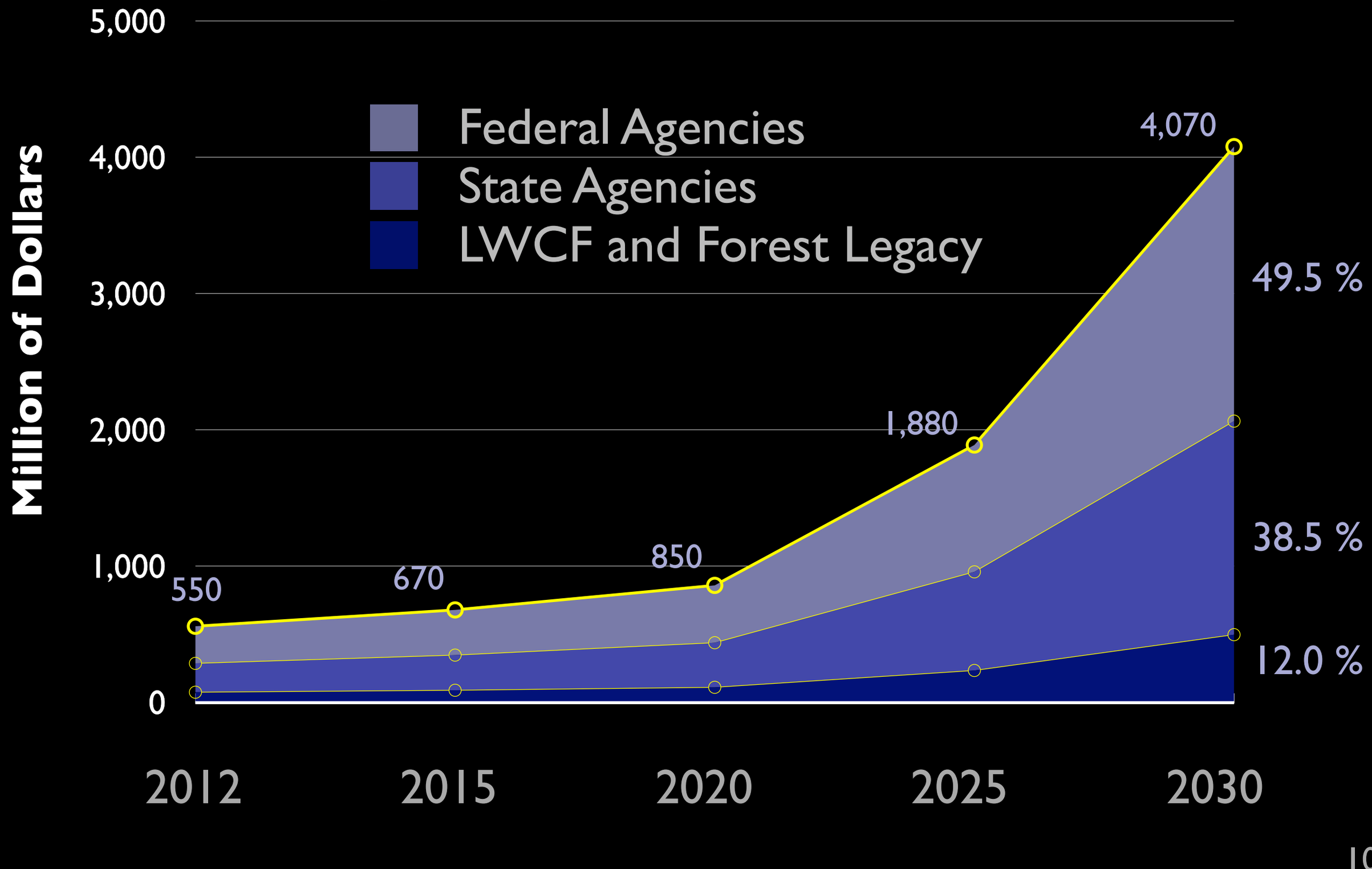
Gamesa Energy photo

ACES: Key Elements of Natural Resource Adaptation Spending

- Establish Interagency Panel (*Year 1*)
- Develop Strategy based on Vulnerability Assessments (*Year 1*)
- Agency Plans Approved by President (*Year 2*)
- State Plans Approved by Agencies (*Year 2*)
- Use of deposits into Adaptation Fund: a separate account, mandatory funding for adaptation purposes only

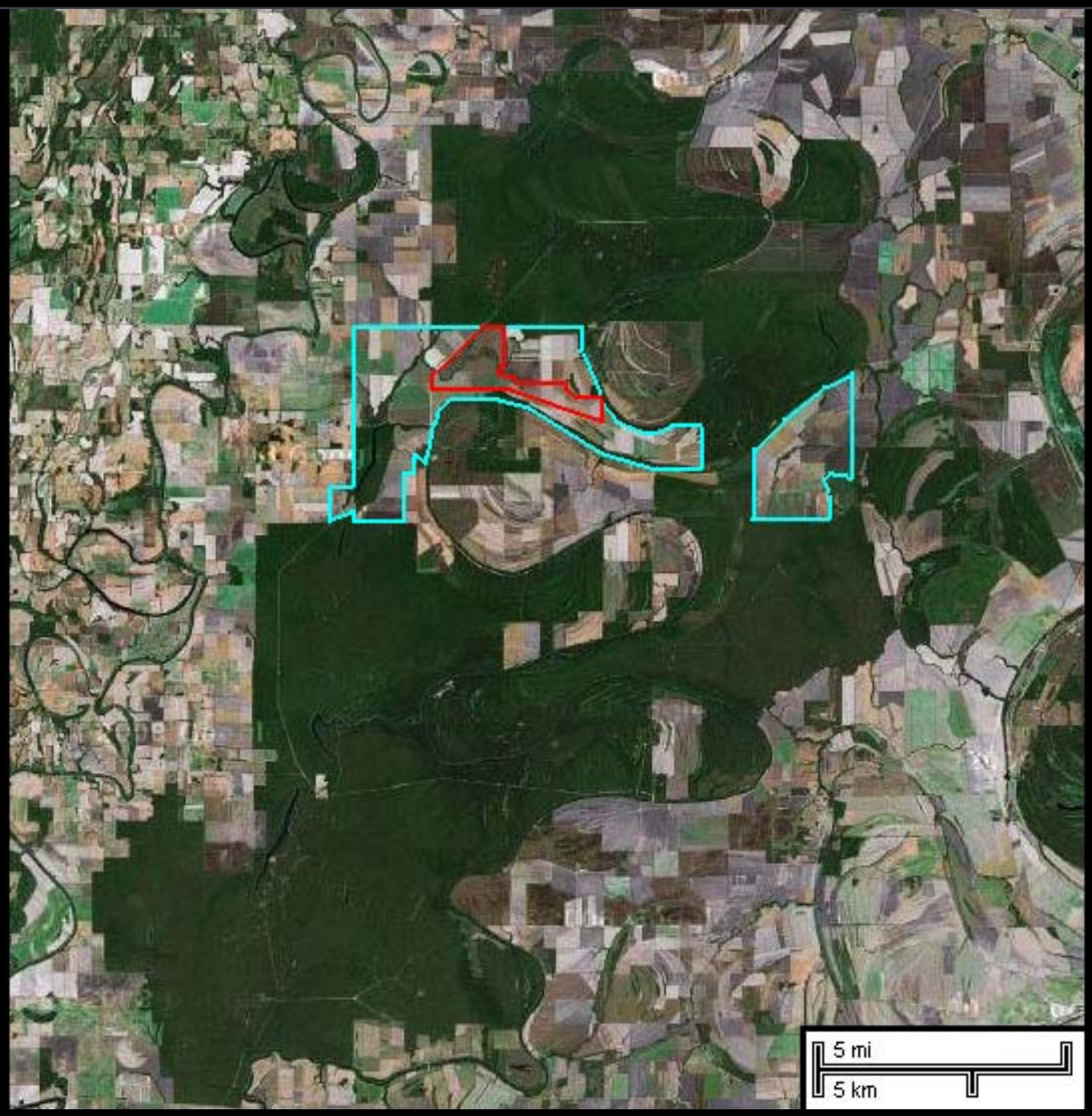
ACES: Increase in Natural Resource Adaptation Allowances Over Time

Using EPA Estimates of Allowance Prices



4.
Managing
Carbon

A Louisiana Example: Tensas River Basin



J. J. Audubon

Source: Carbonfund.org

A Louisiana Example: Tensas River Basin

Source: Carbonfund.org

A Louisiana Example: Tensas River Basin

	Quantity
Acres conveyed to USFWS	8,225
Acres reforested	6,022
Trees Planted	1,818,644
Donated planting costs*	$1,645,000
Land acquisition support*	$3,066,360
Tons of CO_2 sequestered	2,709,900

* Funders include L&WCF, Volkswagen, Entergy

THE TRUST for PUBLIC LAND

Source: TPL, June, 2008

A Louisiana Example: Tensas River Basin

	Cost per Acre ($)
Planting Costs	250
USFWS Management Fee	50
TPL Land Costs	500
Total	**800**

THE TRUST for PUBLIC LAND

Source: TPL, June, 2008

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Categories	What to do?
Adaptation	1. Understand the vulnerabilities and opportunities in your region, and develop a plan to respond.
Engaging others	2. Educate your US Senators; monitor state and local policies. 3. Engage with your community around the vulnerabilities and opportunities identified above.
Managing carbon *(mitigation)*	4. Calculate your organizational carbon footprint; develop a plan to reduce it. 5. Plant trees, lots of trees 6. Monitor the carbon trading scene.

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Acknowledgments

Special Thanks to:

Virginia Farley, Land Connections
Bob Perschel, Forest Guild
Lisa Vernegaard, The Trustees of Reservations
The **Land Trust Alliance**
Miriam Meyer Scagnetti, The Trustees of Reservations
Massachusetts Audubon Society
The **Nature Conservancy**
The **National Trust** of England
Pacific Forest Trust
Matthew Smith, Forecon, Inc.